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The efficacy of an ultrasonic cat deterrent

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Abstract

Ultrasound deterrents for a variety of mammals, including cats, are widely available in the commercial market, but few have been independently tested for efficacy. This study tested the efficacy of an ultrasonic cat deterrent 'Catwatch©', using 63 and 96 volunteer observers in two long-running (18 and 33 weeks) blind experiments. Results indicated that the device did have a moderate deterrent effect, reducing the probability of a cat intrusion into a garden by approximately 32% in the first experiment, but not in the second. The average duration of intrusions was reduced by approximately 38 and 22% in the two experiments, respectively. The magnitude of the deterrent effect appeared to increase with time, since the device was deployed. It is likely that the size of the deterrent effect could be increased by positioning the device(s) more carefully with regard to entry points to the garden that are regularly used by cats.

Keywords: Domestic cat; Cat predation; Ultrasound deterrent; Garden; Exclusion

1. Introduction

Domestic cats *Felis catus* have been responsible for several global extinctions, predominantly on islands (Nogales et al., 2004). There is also considerable concern about the level of predation by domestic cats on dispersed wildlife species in the wider countryside (Churcher and Lawton, 1987; May, 1988). In the UK, Woods et al. (2003)

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estimated that domestic cats may kill in the order of 57 million mammals a year, 27 million birds and 5 million reptiles and amphibians. Barratt (1997) and Lepczyk et al. (2004) recorded high levels of predation of birds, mammals and herptiles in Australia and Michigan, USA, respectively. Both authors concluded that cat depredation was highly likely to have an impact on local populations, though Barratt (1998) cautions against extrapolation from small surveys and also points out that predation estimates alone do not prove that prey populations are detrimentally affected.

It is unclear whether mortality due to cat depredation in the UK is additive or compensatory. Baker et al. (2003) found a negative correlation between woodmouse *Apodemus sylvaticus* and cat abundance in residential gardens in Bristol, UK and suggested that this was evidence that cat predation might be having an effect at the population level. Small passerines have a high mortality rate and cat predation may simply reduce density-dependent mortality, such as starvation. Three bird species, however, (house sparrow *Passer domesticus,* starling, *Sturnus vulgaris* and song thrush *Turdus philomelus*) which appear on the red-list of birds of conservation concern because of recent severe declines in the UK (Gregory et al., 2003) are amongst the most frequently killed species by cats (Woods et al., 2003). Habitat change as a result of agricultural intensification is thought to have driven these declines (Hole et al., 2002; Devereux et al., 2004; Peach et al., 2004). However, gardens cover a greater land area than nature reserves in the UK (Cody and Hume, 1988) and are becoming an increasingly important habitat for birds (Mead, 2000). Such habitat use by birds is likely to lead to cats and potential prey being in close proximity (Ruxton et al., 2002).

Although, the impact of cats on wildlife population trends in the UK is unknown and cats are unlikely to be driving declines of any bird species in gardens, it would be sensible to adopt a precautionary approach to try to reduce predation rates. In addition, cats are often cited as a nuisance by non-cat owners because of their habits of defaecation, digging in flower beds and noise (Proulx, 1988). There are three possible approaches to reducing these problems: implementing curfews (Barratt, 1997; Woods et al., 2003), attaching a warning device to cat collars (Ruxton et al., 2002) and scaring devices. Barratt (1997) points out that night-time curfews are likely to reduce the predation rate of mammals, but not of birds or reptiles. In any case, they are unlikely to be politically acceptable or workable in the UK, where an estimated seven to eight million cats are kept (Woods et al., 2003). Warning devices, such as collar-mounted bells, provide a partial solution for cat owners (Ruxton et al., 2002; Nelson et al., in press). For non-cat owners in the UK, deterrent devices offer the only pragmatic solution.

Commercial cat deterrents are widely available and range from cheap chemical sprays and pellets to more expensive and elaborate equipment, such as ultrasonic devices (Mills et al., 2000). Ultrasound deterrents are marketed for a huge range of mammals, including rodents, bats, cats, dogs, deer and even kangaroos. However, there are very few published field experiments of effectiveness of these ultrasonic devices (Mills et al., 2000). Hurley and Fenton (1980) found little effect of two ultrasonic rodent repellents on little brown bats *Myotis lucifugus*. Curtis et al. (1997) reported no deterrent effect on a device claimed to repel white-tailed deer *Odocoileus virginianus*. Mills et al. (2000) conducted laboratory tests of a commercial ultrasonic cat deterrent and recorded reductions in ear-flicking, exploring activity and time spent within the rage of the device by cats, but no deterrent effect. Bender (2003) found that an ultrasonic deterrent had no discernible effect on the behaviour of eastern grey kangaroos *Macropus giganteus* or red kangaroos *M. rufus.*

Here, we report the results of a field test of the efficacy of a commercially available ultrasonic deterrent on cats in the UK.

2. Materials and methods

2.1. Materials

The device used in experiments was a commercially available ultrasonic device, marketed by Concept Research under the name 'Catwatch©'. The device works by detecting movement and body heat within a range of 12 m, through an angle of 100°. The detection of movement and body heat triggers an ultrasonic alarm that operates at a frequency of 21–23 kHz and a volume of 96 db at 1 m, declining to 56 db at 7 m and 44 db at 13 m and is claimed to be effective in scaring cats at this distance.

2.2. Experimental design

Trials were based on volunteer observations, using a 'blind' experimental design to control for a possible 'placebo' effect. Half the observers were given a working device to trial. The others, unknowingly were given a device that had been disabled and would not emit any ultrasound, but was otherwise indistinguishable. Volunteers were not told that some of the devices had been disabled. They were asked to set up the device in accordance with the manufacturers' instructions: to mount the equipment on the plastic stake supplied or on a wall, so that the lens of the heat/motion detector was 20 cm above ground level. No advice was given as to where in a garden, the device should be located. This allowed us to test the likely average effect of the device as used by the public, rather than the maximum effect that could be achieved through strategic positioning of the device, e.g. at entry points regularly used by intruding cats.

Volunteers were recruited throughout the UK and selected to participate in the survey if they had an average (100–450 m^2) sized, suburban garden, did not already deploy a deterrent device and experienced more than five cat visits to their gardens every week. Experiments were carried out in 2001/2002 and 2003. The experimental design was changed in 2003 (experiment 2) in response to the results from 2001 to 2002 (experiment 1).

In experiment 1, 70 volunteers were randomly split into one of four groups (Table 1). A number of volunteers dropped out of the experiment, resulting in a total of 63 and unequal group sizes (Table 1). Those in groups 1 and 2 were given a single ultrasonic device to put

Table 1
Experimental design of experiment 1

Group	Number of volunteers	November	December	January	February	March
1	15 (14)	Active	Active	Active	Active	Active
2	15 (15)	Disabled	Disabled	Disabled	Disabled	Disabled
3	20 (16)	Active	Disabled	Active	Disabled	Active
4	20 (18)	Disabled	Active	Disabled	Active	Disabled

Numbers in parentheses indicate number after drop-out of some volunteers.

in their gardens. Group 1 volunteers were given an active device, group 2 volunteers a disabled device. People in groups 3 and 4 were given two ultrasonic devices, one active device and one disabled device. They were asked to switch the two devices over every month. Trials lasted for a continuous period of 18 weeks from November 2001 to March 2002. Results from this trial indicated that the effect of active devices increased with time (see results); therefore, the experimental design was changed for experiment 2.

In experiment 2, 150 volunteers took part in the trials. Half were given a disabled deterrent and half were given an active deterrent. Entry into the project was staggered from March to May 2003 ending in October 2003, to control for any seasonal variation in cat activity when investigating interactions between device effect and length of time of device deployment (Table 2). As in experiment 1, a number of volunteers dropped out of the experiment, resulting in a total of 96 and unequal group sizes (Table 2).

In each experiment, volunteers were asked to make three 30 min observations in each week, one in the morning (between 07:30 and 10:30 h), one in the middle of the day (between 10:30 and 13:30 h) and one in the afternoon (between 13:30 and 16:30 h). In practice, some volunteers were able to make fewer observations, while others made more (ranging between one and six observations per week), but there was no systematic bias between active and disabled devices in the time of day observations were carried out. During each observation period, they were asked to record whether a cat entered their garden and the duration of each cat visit (in minutes).

2.3. Statistical analysis

Data were analysed using general linear mixed models in SAS (Littell et al., 2002). Fixed effects were assessed by F-tests ($\alpha = 0.05$). Week number was included as a factor rather than a co-variate to account for any step changes in any relationship between device activity and time and for any unusual weeks (e.g. low activity due to bad weather). In the analysis of both experiments, garden was specified as a random factor, to control for any variation between volunteers.

2.4. Rate of intrusion to gardens

Variation in intrusion rate was modelled by logistic regression with binomial error and logit link function. In experiment 1, the response variable was specified as presence (1) or

Table 2
Experimental design of experiment 2

Group	Number of volunteers	March	April	May	June	July	August	September	October
1	25 (17)	Active	Active	Active	Active	Active	Active	Active	Active
2	25 (13)	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
3	25 (12)		Active	Active	Active	Active	Active	Active	Active
4	25 (18)		Disabled	Disabled	Disabled	Disabled	Disabled	Disabled	Disabled
5	25 (18)			Active	Active	Active	Active	Active	Active
6	25 (18)			Disabled	Disabled	Disabled	Disabled	Disabled	Disabled

Numbers in parentheses indicate number after drop-out of some volunteers.

absence (0) in the garden at any point during the week. In experiment 2, the response variable was specified as the number of observations periods during the week in which a cat was recorded with total number of observation periods (1–6) during the week as the binomial denominator. Garden was specified as a random factor (1–63 in experiment 1 and 1–96 in experiment 2) with week (1–18 in experiment 1, 1–33 in experiment 2) and treatment (active = 1, disabled = 0) as fixed factors. The effect of the interaction between week and treatment was tested first before examining main effects.

2.5. Duration of intrusion to gardens

Variation in the length of time for which cats were present in gardens was modelled by log-linear regression with Poisson error and logarithm link function. In both experiments, the response variable was specified as the total length of time for which at least one cat was present in the garden per week/number of observation periods in that week. Garden was specified as a random factor with week and treatment as fixed factors. The effect of the interaction between week and treatment was tested first before examining main effects.

3. Results

3.1. Probability of observing a cat intrusion

In experiment 1, the interaction between device activity and time was significant ($F_{17,754} = 1.81$, $P = 0.0231$; Fig. 1). Mean $\pm$ 1S.E. probabilities of cat presence per week, broken down into the early (weeks 1–9) and late (weeks 10–18) periods of the experiment were 54.2 ± 6.4 and $51.5 \pm 6.5\%$ for disabled devices and $49.9 \pm 6.6\%$ reducing to $33.9 \pm 6.3\%$ for active devices.

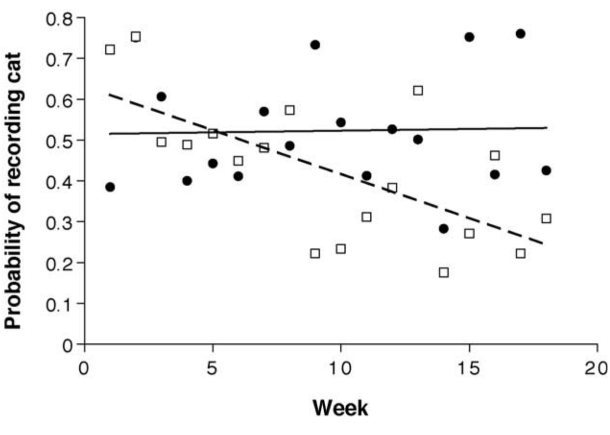

Fig. 1. Temporal variability in the probability of recording a cat intrusion during a week (three observations periods): experiment 1. Filled circles represent fitted mean values per week for disabled devices and open squares for active devices. The solid line represents linear trend for disabled devices and dashed line for active devices.

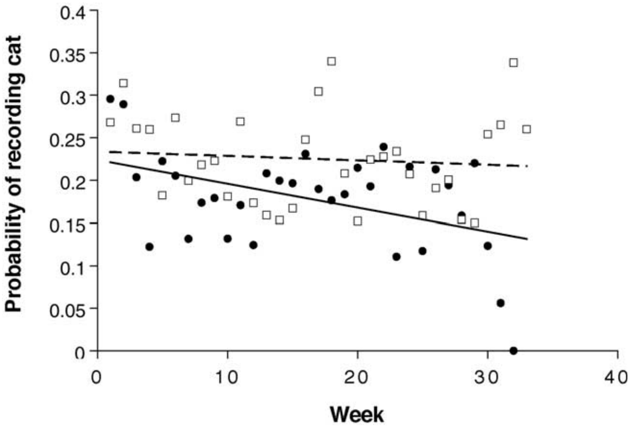

Fig. 2. Temporal variability in the probability of recording a cat intrusion during an observation period: experiment 2. Filled circles represent fitted mean values per week for disabled devices and open squares for active devices. The solid line represents linear trend for disabled devices and dashed line for active devices.

In experiment 2, the interaction between device activity and time was not significant ($F_{32,1742} = 1.04$, $P = 0.414$; Fig. 2) nor was there a significant effect of device activity when controlling for week ($F_{1,1775} = 0.65$, $P = 0.415$). However, there was a significant effect of week when controlling for device activity ($F_{32,1775} = 1.69$, $P = 0.010$).

3.2. Duration of cat intrusions

In experiment 1, the interaction between device activity and time was just significant ($F_{17,754} = 1.66$, $P = 0.046$; Fig. 3). Mean $\pm$ 1S.E. durations of cat presence per observation

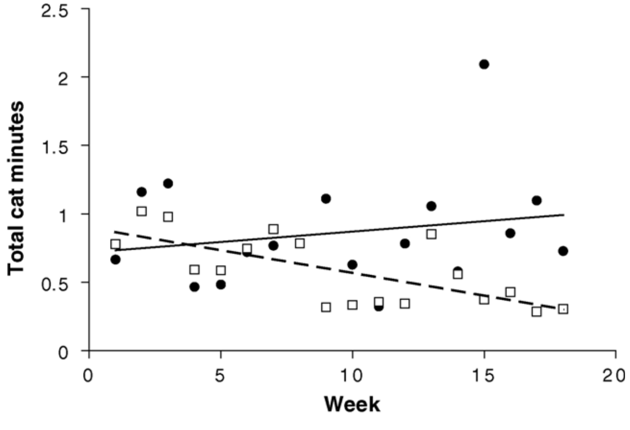

Fig. 3. Temporal variability in the duration of cat intrusions: experiment 1. Filled circles represent fitted mean values per week for disabled devices and open squares for active devices. The solid line represents linear trend for disabled devices and dashed line for active devices.

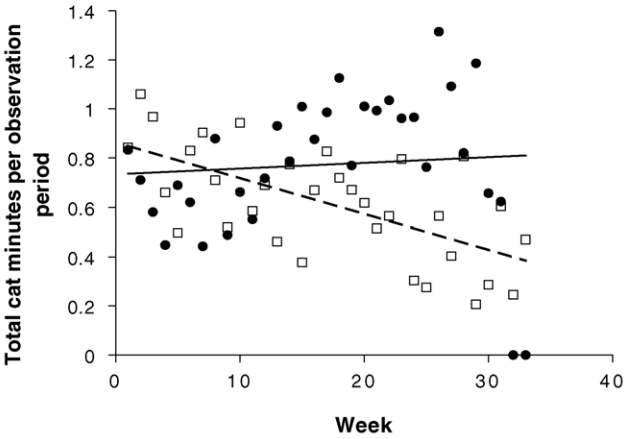

Fig. 4. Temporal variability in the duration of cat intrusions: experiment 2. Filled circles represent fitted mean values per observation period for disabled devices and open squares for active devices. The solid line represents linear trend for disabled devices and dashed line for active devices.

period, broken down into the early (weeks 1–9) and late (weeks 10–18) periods of the experiment were 0.83 ± 0.17 and 0.95 ± 0.19 min for disabled devices and 0.74 ± 0.15 min reducing to 0.46 ± 0.10 min for active devices.

In experiment 2, the interaction between device activity and time was significant ($F_{31,1742} = 1.90$, $P = 0.002$; Fig. 4). Mean durations of cat presence per observation period, broken down into the early (weeks 1–17) and late (weeks 18–33) parts of the experiment were 0.72 ± 0.17 and 0.96 ± 0.24 min for disabled devices and 0.73 ± 0.17 min reducing to 0.57 ± 0.14 min for active devices.

4. Discussion

These experiments were designed to evaluate the effectiveness of an ultrasonic device in deterring cats from entering gardens. 'Catwatch©' operates on a frequency well within the hearing range of cats (Heffner and Heffner, 1985). Laboratory trials of a similar device led Mills et al. (2000) to conclude that there was no threat to cat welfare. Deploying an active 'Catwatch©' device resulted in a small reduction in the probability of a cat entering the garden (significant in experiment 1 only). There was a larger reduction in the duration of intrusions. Both measures of deterrent effect appeared to increase with time over the period of the trials, suggesting that cats were learning to avoid gardens with active devices, rather than becoming habituated to them.

These results suggest that 'Catwatch©' does indeed have a moderate deterrent effect in contrast to Mills et al. (2000), who documented no aversive effect of a similar device in a laboratory trial, although they did record a reduction in exploratory activity. To our knowledge, this is the first study to demonstrate that a purpose built ultrasonic deterrent does have an effect on domestic cats in the field. We purposely set out to test the effect of the device, as it would be deployed by members of the public, according to the manufacturer's instructions. It is probable that the deterrent effect could be improved by deploying multiple devices, carefully sited to intercept cats at the most used entry points to gardens. It is impossible to say whether the magnitude of the effect recorded here would be sufficient to reduce wildlife mortality in gardens with a device or whether this would lead to an effect on the population level. However, 'Catwatch©' would appear to offer a partial solution to people wishing to deter cats from their gardens, motivated either for conservation reasons or because of the nuisance factor.

5. Conclusion

This study clearly demonstrates that the ultrasonic device tested did have a moderate deterrent effect and thus offers a partial solution to householders wishing to exclude cats from their garden. Further research could usefully investigate whether the magnitude of the deterrent effect could be increased by more careful positioning of a device or multiple devices.

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References

Baker, P.J., Ansell, R.J., Dodds, P.A.A., Webber, C.E., Harris, S., 2003. Factors affecting the distribution of small mammals in an urban area. Mammal. Rev. 33, 95–100.

Barratt, D.G., 1997. Predation by house cats, *Felis catus* (L.) in Canberra, Australia. Part 1: prey composition and preference. Wildl. Res. 24, 263–277.

Barratt, D.G., 1998. Predation by house cats, *Felis catus* (L.) in Canberra, Australia. Part II: factors affecting the amount of prey caught and estimates of the impact on wildlife. Wildl. Res. 25, 475–487.

Bender, H., 2003. Deterrence of kangaroos from agricultural areas using ultrasonic frequencies: efficacy of a commercial device. Wildl. Soc. Bull. 31, 1037–1046.

Churcher, P.B., Lawton, J.H., 1987. Predation by domestic cats in an English village. J. Zool. 212, 439–455.

Cody, M., Hume, R., 1988. The Complete Book of British Birds. RSPB, Sandy.

Curtis, P.D., Fitzgerald, C., Richmond, M.E., 1997. Evaluation of the Yard Gard ultrasonic yard protector for repelling white-tailed deer. In: Armstrong, J.B. (Ed.), Proceedings of Eastern Wildlife Damage Management Conference, Jackson, MS, pp. 172–175.

Devereux, C.L., McKeever, C.L., Benton, T.G., Whittingham, M.J., 2004. The effect of sward height and drainage on starlings and lapwings foraging in grassland habitats. Ibis 146 (Suppl. 2), 115–122.

Gregory, R.D., Eaton, M.A., Noble, D.G., Robinson, J.A., Parsons, M., Baker, H., Austin, G., Hilton, G.M., 2003. The State of the UK's Birds: 2002. The RSPB, BTO, WWT and JNCC, Sandy.

Heffner, R.S., Heffner, H.E., 1985. Hearing range of the domestic cat. Hear. Res. 19, 85–88.

Hole, D.G., Whittingham, M.J., Bradbury, R.B., Anderson, G.Q.A., Lee, P.L.M., Wilson, J.D., Krebs, J.R., 2002. Widespread local house-sparrow extinctions: agricultural intensification is blamed for the plummeting populations of these birds. Nature 418, 931–932.

Hurley, S., Fenton, M.B., 1980. Ineffectiveness of fenthion, zinc phosphide, DDT and two ultrasonic rodent repellers for control of populations of little brown bats (*Myotis lucifugus*). Bull. Environ. Contam. Toxicol. 25, 503–507.

Lepczyk, C.A., Mertig, A.G., Liu, J.G., 2004. Landowners and cat predation across rural-to-urban landscapes. Biol. Conserv. 115, 191–201.

Littell, R.C., Milliken, G.A., Stroup, W.W., Wolfinger, R.D., 2002. SAS® System for Mixed Models. SAS Institute, Cary, USA.

May, R.M., 1988. Control of feline delinquency. Nature 332, 392–393.

Mead, C., 2000. The State of the Nation's Birds. Whittet Books, Stowmarket.

Mills, D.S., Bailey, S.L., Thurstans, R.E., 2000. Evaluation of the welfare implications and efficacy of an ultrasonic 'deterrent' for cats. Vet. Rec. 147, 678–680.

Nelson, S.H., Evans, A.D., Bradbury, R.B. The efficacy of collar-mounted devices in reducing the rate of predation of wildlife by domestic cats. Appl. Anim. Behav. Sci., doi:10.1016/j.applanim.2005.04.003.

Nogales, M., Martin, A., Tershy, B.R., Donlan, C.J., Witch, D., Puerta, N., Wood, B., Alonso, J., 2004. A review of feral cat eradication on islands. Conserv. Biol. 18, 310–319.

Peach, W.J., Denny, M., Cotton, P.A., Hill, I.F., Gruar, D., Barritt, D., Impey, A., Mallord, J., 2004. Habitat selection by song thrushes in stable and declining farmland populations. J. Appl. Ecol. 41, 275–293.

Proulx, G., 1988. Control of urban wildlife predation by cats through public education. Environ. Conserv. 15, 358–359.

Ruxton, G.D., Thomas, S., Wright, J.W., 2002. Bells reduce predation of wildlife by domestic cats (*Felis catus*). J. Zool. (Lond.) 256, 81–83.

Woods, M., McDonald, R.A., Harris, S., 2003. Predation of wildlife by domestic cats *Felis catus* in Great Britain. Mammal. Rev. 33, 174–188.