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Title	An investigation into the techniques for detecting hedgehogs in a rural landscape
Authors	Haigh, Amy;Butler, Fidelma;O'Riordan, Ruth M.
Publication date	2012-11-23
Original Citation	Haigh, A., Butler, F. and O'Riordan, R. M. (2012) 'An investigation into the techniques for detecting hedgehogs in a rural landscape', Journal of Negative Results, 9(1), pp. 15-26.
Type of publication	Article (peer-reviewed)
Link to publisher's version	http://jnr-eeb.org/index.php/jnr/article/view/43
Rights	© 2012, Journal of Negative Results.
Download date	2026-11-11 05:40:16
Item downloaded from	https://hdl.handle.net/10468/2594

UCC
University College Cork, Ireland
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Journal of Negative Results
— Ecology & Evolutionary Biology —
vol. 9: 15–26 • Helsinki, 23 November 2012
ISSN 1459-4625
http://www.jnr-eeb.org/

An investigation into the techniques for detecting hedgehogs in a rural landscape

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Received 24 September 2011, accepted 24 April 2012

Various techniques and devices have been developed for the purpose of detecting wildlife but many only provide optimum results in particular habitats, for certain species or under ideal weather conditions. It is therefore advantageous to understand the efficiency and suitability of techniques under different scenarios. The effectiveness of methods for detecting rural Irish hedgehogs was investigated as part of a larger study in April 2008. Road kill sightings and questionnaires were employed to locate possible hedgehog sites. Six sites were subsequently selected, and in these areas trapping, spotlighting and foot print tunnels were employed to investigate whether hedgehogs were indeed in the surrounding landscape. Infrared thermal imagery was examined as a detection device. Trapping and infrared imagery failed to detect hedgehogs in areas where they had previously been recorded. Footprint tunnels proved to be unsuccessful in providing absolute proof of hedgehogs in an area. No single method of detection technique could be relied upon to conclude the presence of hedgehogs in an area. A combination of methods is therefore recommended. However, spotlighting was the most effective method, taking a mean of 4 nights to detect a hedgehog, in comparison to 48 nights if footprint tunnels were used as a sole method of detection. This was also suggested by rarefaction curves of these two detection techniques, where over a 48 night period hedgehogs were expected to be recorded 27 times through spotlighting and just 5 times in an equivalent period of footprint tunnel nights.

Introduction

Initial detection of an animal in an area is one of the first major obstacles to any ecological research. Wildlife research projects and management plans depend on accurate estimation of species abundance (St-Laurent & Ferron 2008), for evaluating the effects of habitat manipulations or status of prey bases (Menkens & Anderson 1988) and investigating habitat preferences and home range size (Lemen & Freeman 1985). However, reliable monitoring techniques are often fraught with difficulties, and may only be effective in specific habitat types or for certain species. A number of monitoring methods for a range of mammalian species have been utilised with varying degrees of success. These include mark recapture (Henderson 2003), distance sampling (Anderson *et al*. 1983, Barry & Welsh 2001, Royle *et al*. 2004), spot sampling (Russ & Montgomery 2002, Heikkinen *et al*. 2004), infrared thermal imagery (Boonstra *et al*.

Editor in charge of this manuscript: Mike Fowler

1994, Sabol & Hudson 1995, Butler *et al*. 2006), fluorescent tracers (Frantz 1972, Evans & Griffith 1973, Lemen & Freeman 1985), tracks and signs (Lawrence & Brown 1973), marked baits (Delahay *et al*. 2000), spotlighting (Reynolds & Short 2003, Tannerfeldt & Thiel 2004), road kill surveys (Philcox *et al*. 1999, Baker *et al*. 2004, Seiler *et al*. 2004), questionnaires (Hof & Bright 2012) and stable isotope analysis (Peterson & Fry 1987, Alisauskas & Hobson 1993).

Due to their small size, and nocturnal, secretive nature, hedgehogs repeatedly go undetected in an area. Their presence is often only concluded when they appear as road kill or when they are observed in urban gardens. This is not surprising as they are one of the most frequently killed animals on, for example, Irish (Sleeman *et al*. 1985, Smiddy 2002), Dutch (Huijser *et al*. 1998), Belgian (Holsbeek *et al*. 1999) and Slovakian (Hell *et al*. 2005) roads. In many small mammal studies, traps are used as a means of capture (Claassens & O'Gorman 1965, Baker *et al*. 2003). There are no traps specifically designed for hedgehogs, but, in studies by Riber (2006) in Denmark and Hof (2009) in the UK rabbit traps were used. With low capture rates, this method was subsequently abandoned in favour of spotlighting (Riber 2006, Morris pers. comm. 2008, Hof 2009).

Hedgehogs can run fast, reaching average speeds of 30-40 metres per minute (Morris 2006) but they will often not run when approached and will, instead, roll up, relying on their spines for protection. Therefore many studies (Kristiansson 1981, Reeve 1982, Cassini & Krebs 1994, Dowding 2007, Hof 2009, Hof & Bright 2010) have adopted capture by hand, having first located animals with a high powered spotlight.

Huijser and Bergers (2000) deployed footprint tunnels to study road avoidance by hedgehogs in the Netherlands. They compared the number of hedgehogs using tunnels with the numbers caught when the tunnels were removed and replaced by traps. Harris and Yalden (2004) believed that this method would be the most successful monitoring tool for estimating hedgehog abundance in an area.

As part of a larger study on the ecology of hedgehogs in Ireland, the current study aimed to test the following hypotheses that: (1) In view of the previous lack of success, trapping is unsuccessful for detecting hedgehogs, (2) Questionnaires, road kill surveys, footprint tunnels or infrared thermal imagery can be used as sole methods for detecting hedgehogs in an area, and (3) Spotlighting is the most effective method for detecting hedgehogs in an area.

Material and methods

In total, five methods were employed in order to investigate the presence of hedgehogs in an area. These involved engaging members of the public through completing questionnaires, recording road kill as well as direct searching using trapping and foot print tunnels.

Road kill survey

In March 2008, an appeal was sent out on the University College Cork website asking for volunteers to take part in a road kill survey in Counties Cork and Galway. A meeting was held amongst eight volunteers who regularly travelled a specific route. They were supplied with maps of their route and asked to record the date and grid reference for each hedgehog casualty located. There was no prior knowledge of whether hedgehogs were present along the route, with specifications being purely based on how regularly the surveyor travelled a given road on a weekly basis. In April 2008, surveyors began recording hedgehog carcasses along their route.

Public survey

A questionnaire (*see* Appendix) was distributed in June 2008 to agricultural colleges, organic farmers, stud farmers, mart stores and local supply and pet shops in County Cork. Golf courses and households near potential field sites where further searches were being conducted were also visited in order to ask about hedgehog sightings. The survey was also supplied to www.biology.ie (a website for recording sightings of Irish wildlife), the Irish National Parks and Wildlife Service and Coillte (the Irish forestry service) to be placed on their websites. In accordance

with the recommendations of White *et al*. (2005) the question and answer format were kept as simple as possible. People were asked to indicate any information on habitats, months and times when hedgehogs were sighted, as well as how regularly they were seen i.e. was the sighting a once off or were hedgehogs regularly observed at the site. They were also encouraged to reply if they had never seen hedgehogs at that particular site.

Six suitable sites were subsequently selected based on known hedgehog habitat preferences, records of past sightings, and the presence of road kill (Table 1). Five of these sites were situated in Munster and one in Connaught.

Footprint tunnels

Footprint tunnels consisted of a plastic board, 20 × 50 cm on to which heavy grade (140 gm) white paper was attached. At each end of the paper a thin layer of graphite powder mixed with paraffin oil was placed over about ~10 cm of the paper. The tunnels were baited with cat food as an attractant. Corrugated plastic was placed over the boards (29 cm high) which were secured to the board with tent pegs. The tunnels were placed along hedgerows and edge habitat. The tunnels were checked daily and, if used, the paper and bait were changed. In April 2008, 45 tunnels were deployed over 27 nights. In June 2008, 10 were placed at the farm in Ballinhassig for seven nights and 20 for a further four nights (Table 2). Five were also placed in a garden in Ratharoon near Bandon for 24 nights, where hedgehogs were seen regularly.

Traps

Sixteen rabbit traps (60 × 19 × 19 cm) (Animal Care Ltd.) were used in Riverstick in May 2008 for 11 nights (Table 2). Traps were placed along hedgerows, covered with vegetation and baited with cat food. Traps were checked daily at 5 am and rebaited if necessary.

Table 1. The six sites which were monitored for hedgehogs, and method of detection used at each.

Site	Habitat	Presence of hedgehogs	Other mammals recorded	Detection method used
Riverstick, Co. Cork	Mixed farmland with small areas of woodland	Previously seen close to the site	Foxes (*Vulpes vulpes*), rabbits (*Oryctolagus cuniculus*)	Spotlighting, trapping, footprint tunnels
Ballygarvan, Co. Cork	Organic mixed farmland	Occasional sightings of live hedgehogs	Foxes, rabbits, badgers (*Meles meles*) and hares (*Lepus timidus hibernicus*)	Spotlighting
Ballinhassig, Co. Cork	Mixed farmland with small areas of woodland	Yearly sightings both alive and as road kill	Foxes and rabbits	Footprint tunnels and spotlighting
Muskerry, Co. Cork	Golf course-mature woodland, open grassland and farmland	Occasional sightings of live hedgehogs, road kill	Foxes and rabbits	Spotlighting
Ratharoon, Co. Cork	Mixed farmland	Sightings of live hedgehogs	Foxes, badgers, rabbits, hares, stoat (*Mustela erminea hibernicus*) and mink (*Mustela vison*)	Footprint tunnels and spotlighting
Castlehackett, Co. Galway	Mixed farmland with areas of woodland	Yearly sighting of both adults and offspring. Road kill collected nearby	Badgers, pine marten (*Martes martes*), fox and fallow deer (*Dama dama*)	Spotlighting

Spotlighting

At the end of April 2008, direct searching using spotlights began. This consisted of a search of 2 hours after dusk, four nights a week, with a 2 million candle power spotlight (Lightforce). Spotlighting took place at five of these sites over 23 nights for 53 hours (Table 2). At the Ratharoon site spotlighting was extended to four hours, with part of this time spent driving around the roads bordering the site.

Tracking

Tagged hedgehogs became useful for detecting other individuals and this was particularly the case during the breeding season, when a number of males (up to 3 were observed, Haigh 2011) were engaged in courtship displays with an individual female. Hedgehogs that were captured between 26 June 2008 and 28 September 2008 were monitored by direct following for a period of 23 nights.

All adult hedgehogs (above 600 g) caught after 28 September 2008 were fitted with radio tags. Eight individuals were fitted with 173 MHz, R1-2B transmitters (Holohil) and attached to the animal after the manner of Jackson and Green (2000), i.e. Velcro was sown around the radio transmitters and attached to a clipped area of spines to which a corresponding piece of Velcro was glued. The entire tag weighed 10 g and was 0.94% of the mean adult hedgehogs' weight and 3.57% of the weight of the smallest juvenile. Animals were then tracked using a SIKA receiver (BIOTRACK). Data were collected from eight individuals over a total of 33 nights from 28 September 2008 until hibernation in November 2008. A minimum of six fixes were obtained for each individual per night. All procedures were carried out in accordance with current regulations; licenses (numbers 21/2008 and C48/2008) were obtained from the Department of Environment, Heritage and Local Government.

Infrared thermal imagery

When hedgehogs were radiotagged at the site, the use of a handheld infrared thermal imagery camera (Testo 880 range) was tested as a tool for hedgehog detection. Thermal infrared imaging systems which take heat pictures, allow detection of warm blooded animals against a relatively cooler background with or without the presence of visible light (Sabol & Hudson 1995). The camera was tested in three different habitat types at the Ratharoon site: arable (wheat ~ 30 cm), garden and pasture. The camera was first trialled without knowledge of whether any of the tagged hedgehogs were present and later when the hedgehog's location was known to examine the distance of possible detection.

Data analysis

Means are followed by ± SE unless stated otherwise. The Kolmogorov-Smirnov test was performed to evaluate normality of the data, using the Brodgar software, version 2.6.3. Data were not normally distributed and all analyses were performed using χ^2-test in PASW Statistics, version 1. A comparison of the success of detection techniques was assessed by computing rarefaction curves using the 'estimate S' programme (Colwell 2009). This predicted the expected capture success of each method based on the results obtained when each technique was trialled.

Table 2. Sampling effort of each detection technique at each site.

	Riverstick, Co. Cork	Ballygarvan, Co. Cork	Ballinhassig, Co. Cork	Muskerry, Co. Cork	Ratharoon, Co. Cork	Castlehackett, Co. Galway
Spotlighting	24 hours (10 nights)	8 hours (4 nights)	8 hours (4 nights)	5 hours (3 nights)	215 hours (48 nights)	8 hours (2 nights)
Tunnels	385 tunnel nights	N/A	150 tunnel nights	N/A	120 tunnel nights	N/A
Traps	176 trap nights	N/A	N/A	N/A	N/A	N/A

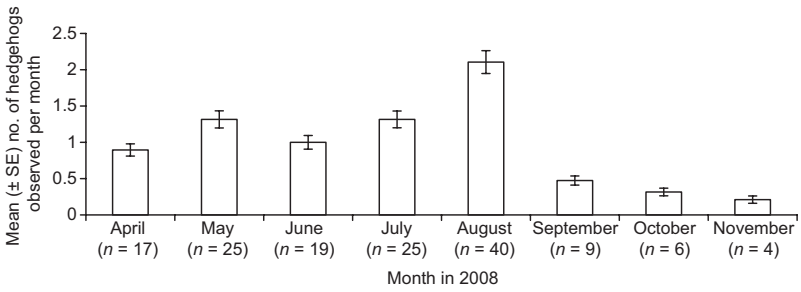


Fig. 1. The months in which hedgehogs were observed as road kill, on eight routes surveyed weekly, County Cork, 2008.

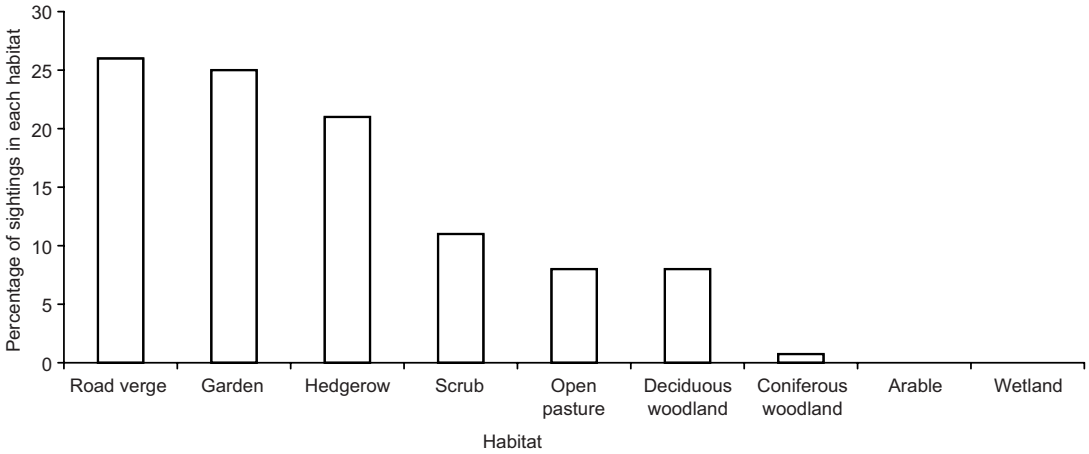


Fig. 2. Sightings of hedgehogs in habitats from the public survey (n = 128).

Results

Road kill survey

One hundred and forty five hedgehogs were recorded as road kill during 2008 by eight volunteers in County Cork. There was substantial variation in the months hedgehogs were recorded as road kill (χ^2 = 63.02, df = 7, $p < 0.001$). The majority (n = 126) were recorded between April and August, with only 19 documented after this time (Fig. 1).

Road kill as a detection method

Hedgehogs were recorded as road kill at Ballinhassig, Muskerry and Castle Hackett on five occasions in total during the study period. They had also been recorded annually by residents at these sites. However, despite this no live hedgehogs were detected at any of these three sites during subsequent surveying.

Public survey

There was a 40% response to the questionnaire survey (88 written + 40 phone replies /320). Hedgehogs were reported in 10 habitats but there was variation in the habitats where hedgehogs were observed (Fig. 2) (χ^2 = 95.09, df = 8, $p <$ 0.001). Of those surveyed, 26% had observed hedgehogs along road verges, 25% in their gardens and 21% in hedgerows. In the other eight listed habitats hedgehogs were observed on only 0-8% of occasions (mean 3.6 % ± 0.23).

There was variation in the months in which respondents reported seeing hedgehogs (χ^2 = 98.25, df = 11, $p < 0.001$). Unsurprisingly, the majority of sightings (57%) (mean 19.0 % ± 0.23) of hedgehogs were in the summer months (May–July) (Fig. 3). In the other nine months hedgehogs were observed on just 1-10% of occasions (mean 4.8 % ± 0.23).

Hedgehogs were observed to a greater extent at particular times of the night (χ^2 = 12.06, df

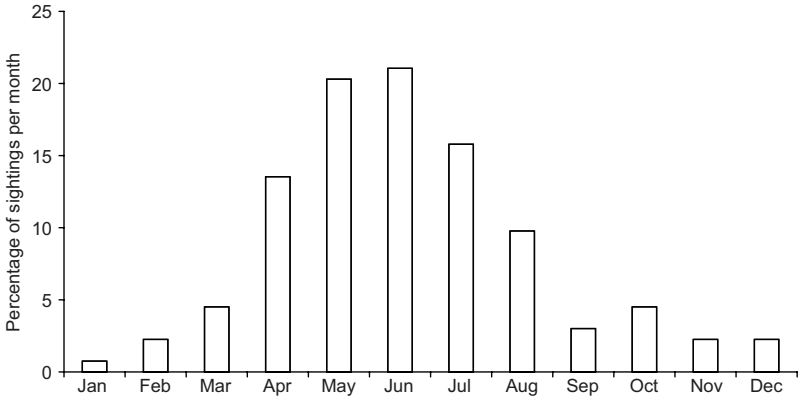


Fig. 3. Percentage of sightings in each month that respondents had seen hedgehogs (n = 128).

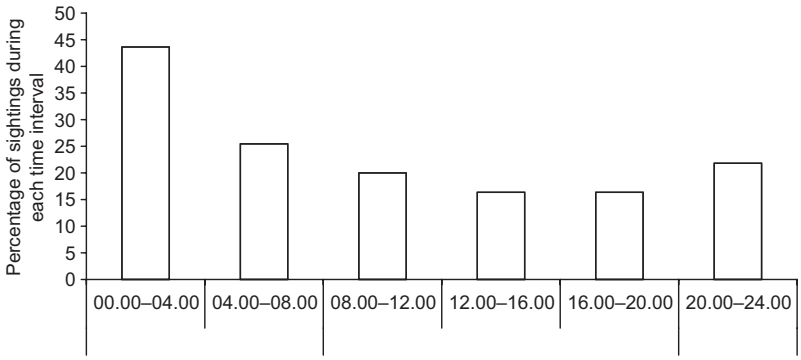


Fig. 4. The percentage of hedgehog sightings within each time period referred to in the survey.

= 5, p = 0.002), with the majority (n = 44%) of respondents sighting hedgehogs between the hours of midnight and 4 am than at other hours of the day/night (Fig. 4). The frequency with which respondents had seen hedgehogs varied, but was non-significant (χ^2 = 3.00, df = 8, p = 0.158): 29% of respondents had seen hedgehogs between 1–5 times, 24% only once, 28% regularly, 13% greater than 5 times and 6% not at all. The majority of sightings were solely of live animals (56%), while 17% were seen as road kill only and 27% as both road kill and alive.

At Ratharoon in a door to door survey of people in the immediate vicinity of the site, ten of the 30 respondents had seen hedgehogs in the area. Two of these people had observed them as road kill but not in the previous two years. Of the people who were aware of them in their area, four had been alerted to the presence of hedgehogs by their dogs attacking them in their garden. However, there was a further twenty households who were unaware of hedgehogs in their area. Farmers, who were asked, recalled seeing hedgehogs when they worked on the land when young but not in recent years.

Footprint tunnels

The deployment of tunnels proved surprisingly disappointing (Table 3). Tunnels were not used regularly by hedgehogs and in many cases were not used at all. In the Riverstick site hedgehogs were never recorded to use tunnels. In Ballinhassig one of the tunnels that were placed in the garden was used by a hedgehog on one occasion. In Ratharoon, hedgehog prints were believed to be recorded on twelve occasions, successfully indicating their presence at the site, but occurrence was low, with a high incidence of use by non-target animals (rodents and domestic cats). Also, as some of the prints had been obscured, some of these records may be dubious. Meanwhile, tunnel use by non-target animals represented 67% of records. On the remaining occasions the food either remained in the tunnels the following day (14%) or the bait was gone but there were no footprints (9%). On occasions when hedgehogs were caught by spotlighting in the garden at Ratharoon, the tunnels remained

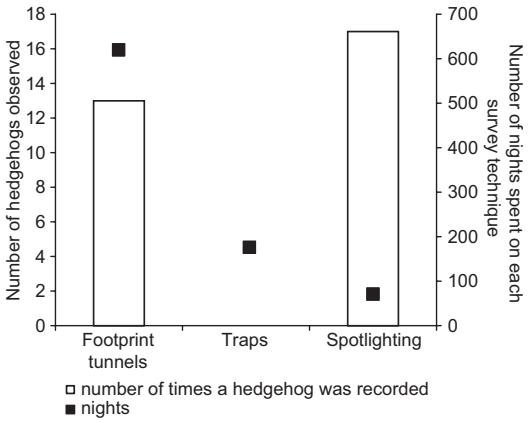


Fig. 5. The number of nights spent on each detection method and the number of hedgehogs detected in that time.

unused by them.

There was variation in the use of the tunnels ($\chi^2 = 396.09$, df = 4, $p < 0.001$) by different taxa, and the tunnels were used by small rodents ($p < 0.01$) more than any other animal (binomial test).

Traps

During the 176 trap nights at Riverstick no hedgehogs or non-targets animals were captured.

Spotlighting

Spotlighting efforts were concentrated along edge habitat in each of the six sites. Direct searching using spotlights was carried out for 53 hours over 23 nights, during which hedgehogs were not detected at five of the sites. At the sixth site (Ratharoon) on 17 nights, within the 48 night study period, seven hedgehogs were located and caught. However, there was a further 31 nights (120 hours), within the study period, when no hedgehogs were located using this method. Despite this, spotlighting was the most effective detection technique. Hedgehogs were detected on average within 4 nights using this method, while it took an average of 48 nights to identify their presence using footprint tunnels (Fig. 5).

This was also verified by computing rarefaction curves for spotlighting and footprint tunnels at Ratharoon, where hedgehogs were found to be present. Based on the number of hedgehogs found per night using each method, spotlighting was again found to be more effective than footprint tunnels at this site. For example it was predicted that in a 48 night period, hedgehogs were expected to be recorded on 27 occasions by spotlighting and just five times in 48 footprint tunnel nights (Fig. 6).

Tracking

Between June 2008 and June 2010, 24 hedgehogs were caught at Ratharoon. Of these 17 (71%) were first caught when spotlighting and 13% of hedgehogs were found while driving around the site. Four males (16%) were first captured during courtship displays and many were also recaptured when tags fell off. It was possible to identity these individuals as all of the hedgehogs had been fitted with P.I.T (Passive integrated transponder) tags at the time of capture. This was also a useful time to detect hedgehogs as the loud vocalisations during these displays were good indicators of their presence.

Table 3. Use of tunnels over the period that they were baited.

	Riverstick Site (350 tunnel nights)	Ballinhassig Site (150 tunnel nights)	Ratharoon Site (120 tunnel nights)
Bird	8	16	1
Domestic dog/cat	17	2	45
Hedgehog	0	1	12
No footprints	88	37	17
No footprints but food gone	39	31	17
Rat	34	28	25
Unknown rodent	186	39	3

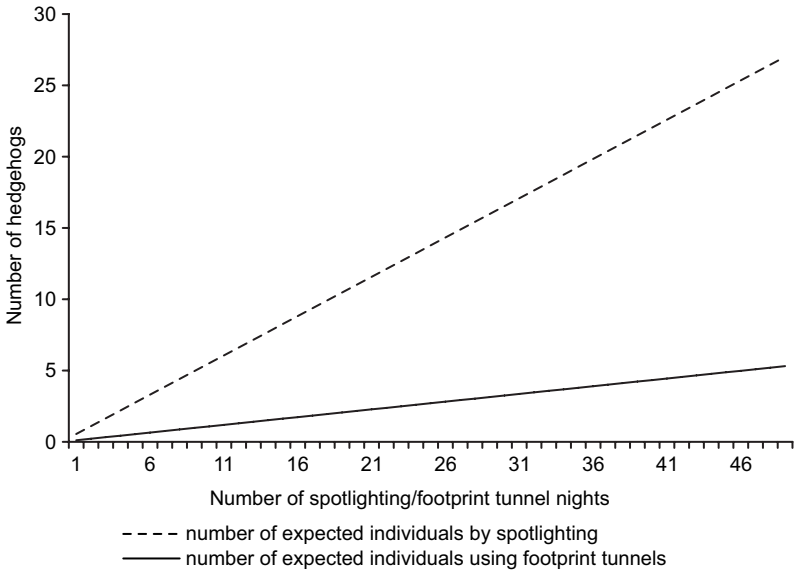


Fig. 6. Rarefaction curves showing the number of expected hedgehog records when using spotlighting or footprint tunnels over a 48 night period.

When hedgehogs were directly followed only one individual was followed per night and a mean of 21 (± 0.16) fixes were obtained per individual per night. When hedgehogs were radio tracked, up to six were tracked during a night and a mean of 6 (± 0.01) fixes were attained per individual per night.

Infrared thermal imagery

The infrared camera did not detect hedgehogs in garden, pasture or arable land. The detection distance was found to be less than 1 m and even when the location of the hedgehog was known, the device had to be positioned close (< 1 m) to the individual before the hedgehog was detected by the device.

Discussion

Road kill counts have often been used as effective indicators of population declines and species abundance (Philcox *et al*. 1999, Baker *et al*. 2004, Seiler *et al*. 2004). In three of the study sites (Ballinhassig, Castlehackett and Muskerry) hedgehog road kill had been seen annually for a number of years and during the present study period. However, live hedgehogs failed to be detected over the study period. In the site at Ratharoon, road kill had not been recorded at the site by those who responded to the survey (n = 30), for the previous two years. The lack of road kill did not reflect the high abundance of the species at the site. Baker *et al*. (2004), when examining fox road kill data, found that short term (i.e. 3 months) counts of road traffic casualties were expected to be variable and less likely to indicate density and that small numbers of casualties are likely to be a limiting factor for the application of such techniques for monitoring populations. Road kill could therefore not be relied upon to indicate the presence of hedgehogs in areas where traffic was minimal and road casualties correspondingly low. The majority of survey respondents sighted hedgehogs in their gardens or along road verges. This emphasises some of the limitations that such questionnaires can have, due to the biases created by people's changing lifestyles and the fact that hedgehogs are often only detected when killed on the road or when they enter the public domain. In Ratharoon, where hedgehogs were found at a density of 3.07 per ha (Haigh 2011), in a door to door survey of people in the immediate vicinity of the site, ten of the 30 respondents (33%) had seen hedgehogs in the area. However, there was a further twenty households (67%) who were unaware of hedgehogs in their area. Farmers, who

were asked, recalled seeing hedgehogs when they worked on the land when young but not in recent years. This may reflect a genuine reduction in hedgehog numbers. However, it could also be a consequence of people's changing lifestyles and the reduction in the chance of detection due to the increased use of machinery and subsequent lack of direct contact with the land. Therefore, while questionnaires can be useful to detect the presence of hedgehogs in an area, a lack of detection by respondents cannot be relied upon as a guarantee of their absence. This again highlights the importance of utilising more than one detection method.

In work by Huijser and Bergers (2000), footprint tunnels proved to be successful and the use of the tunnels by hedgehogs was closely correlated with the total number of individual hedgehogs that were caught in traps immediately after the tunnels were removed. However, in the present study the tunnels were used much more frequently by non-target species such as small mammals and birds. In experiments with a hedgehog that was being rehabilitated in an enclosed garden, it was found not to enter the tunnel if other food was left out for it. It would only walk through the tunnel if given no other option (unpublished work). At Ratharoon where hedgehogs were caught on a regular basis, hedgehogs were found to use the tunnels only occasionally. In total they were believed to have been used on 12 occasions in 120 tunnel nights by hedgehogs. This was despite the fact that hedgehogs were regularly observed in close proximity to the tunnels.

Although traps have been used for the control of hedgehogs by game keepers (Yalden 1976), recent research on hedgehogs has reported little capture success (Morris 1986, Riber 2006). In a survey on diet by Yalden (1976), hedgehog carcasses were obtained from game keepers. In spring the estate in question operated 300-500 traps and they caught about 260 hedgehogs per annum (Yalden 1976). These traps were fenn traps and so unsuitable for research such as this and not directly comparable. However, it is probable that this area supported a higher density of hedgehogs than other areas where trapping has been unsuccessful. Riber (2006) caught two hedgehogs in ten rabbit traps over a ten week period. In comparison, she caught 29 when searching by spotlight. Low capture success was also reported by Hof (2009), where a total of 2084 effective trap nights in a rural area of approximately 50 ha in Kent, resulted in the capture of only one hedgehog. This lack of success of footprint tunnels and trapping in this study, and trapping in studies by Morris (1986), Riber (2006) and Hof (2009) suggest that hedgehogs may exhibit a form of neophobic behaviour, similar to that displayed by rats (Barnett 1958). Therefore, tunnels and traps may need to be placed at a site for longer, in order to reduce the effects of avoidance behaviour. As hedgehogs often appear at low densities (Egli 2004), particularly in rural areas, a large number of tunnels and traps would have to be utilised to obtain a definite indication of their presence. Tunnels must be checked regularly in case of the tracks being obscured by non-target animals entering later. This would take considerable time effort and the current study indicated that a greater return could be expected through spotlighting.

In total 53 hours were spent spotlighting at five of the six sites over a 23 day period. In this time no hedgehogs were observed either alive or as road kill. At the Riverstick site a door to door survey revealed that hedgehogs had been seen occasionally in the previous few years in the area, at a number of neighbouring houses. It was therefore surprising that over the 24 hours and ten days spent spotlighting in Riverstick, as well as the monitoring of traps and tunnels, that hedgehogs were not encountered. At three of the other sites none were detected through spotlighting, despite hedgehogs having been seen annually both alive and as road kill. In Ballinhassig, hedgehog carcasses were observed on three occasions within 0.5 km of the site in 2008. Two hedgehogs were also found drowned in a cattle grid on the farm at Ballinhassig in August 2008, after extensive rainfall. They therefore appeared to regularly use the area, so it is surprising that they were undetected through spotlighting. In Ratharoon, where hedgehogs were eventually found at a density of 3.07 per ha (Haigh 2011), spotlighting had been carried out for ten hours over four days before the first hedgehog was caught. Hedgehogs were found on 17 occasions over a period of 48 nights (Haigh 2011). How-

ever, in this time there were a further 31 nights and 120 hours when hedgehogs were not seen, despite extensive spotlighting.

Infrared thermal imagery was unsuccessful in detecting hedgehogs at the Ratharoon site. Boonstra *et al*. (1994) found the method successful for detecting red squirrels, Arctic ground squirrels, snowshoe hares and meadow jumping mice in Canada, but stipulated that a direct line of sight was necessary, as dense undergrowth could block the image. In the current study even a clump of long grass prevented detection of the hedgehog by the device. Similarly, Sabol and Hudson (1995) reported that although emerging bats appeared bright against a dark cool cave mouth, they disappeared from the thermal imagery view once they flew in front of the warm vegetation surrounding the cave. As well as being restricted to certain times of the day when the sun has largely dissipated or not yet heated the ground vegetation (Boonstra *et al*. 1994), a stationary background is also an absolute requirement (Sabol & Hudson 1995). These limitations were also encountered by Butler *et al*. (2006) who found that ground cover obscured bedded fawns and that fawns were identified only at distances of < 1 m, when vegetation was not dense. With the high cost of the equipment, restricted ideal conditions that are necessary and the proximity to which one has to be to the individual for detection, it did not prove to be an effective method in this habitat for hedgehog detection.

This study further emphasises some of the limitations involved in the initial detection of a small nocturnal animal, such as the hedgehog. It therefore highlights the importance of long term monitoring of a site before declaring hedgehogs absent. It also stresses the importance of utilising more than one detection device (for instance spotlighting combined with questionnaires or road kill surveys) in order to minimise these effects. As has been observed in previous studies, trapping proved unsuccessful for detecting hedgehogs. Questionnaires, road kill surveys and infrared thermal imagery all proved ineffective as sole methods of hedgehog detection. The most successful method of capture proved to be spotlighting. This was particularly the case during the breeding season (April-July), when this usually solitary and quiet mammal was engaged in courtship displays, and vocalisations facilitated detection.

Acknowledgements

The authors would gratefully like to acknowledge the assistance of the following people, Digger Jackson, Pat Morris, Nigel Reeve and Anouschka Hof for their invaluable advice on hedgehog research at the start of this work, and to Helen Bradley for all of her many hours of assistance with G.I.S. We also thank The Department of Environment, Heritage and local Government for granting licenses, the Crawford Hayes fund for PhD scholarship and all the staff and students in U.C.C who assisted in this study. Finally this study would not have been possible without the assistance of the land owners, who co-operated throughout this study and all of the people who participated in the survey.

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Appendix: Hedgehog survey 2008.

Name: Address:

Email: Telephone:

1. Are you aware of hedgehogs in the vicinity of your home/farm?
   Yes ☐ No ☐

2. How are you aware?
   Live sightings ☐ Road kill ☐
   Other (please specify)_____

3. Is the area you live:
   Urban ☐ Suburban ☐ Rural ☐

4. When was the last time you saw them dead or alive (approximately)?
   This year ☐ 1–2 years ago ☐ > 2 years ago ☐

5. Have you seen them:
   Once ☐ Regularly ☐ 1–5 Occasions ☐ > 5 times ☐ Never ☐

6. At what time did you approximately see the hedgehog ?
   _____am _____pm

7. At what time of year did you see them?
   January ☐ February ☐ March ☐ April ☐
   May ☐ June ☐ July ☐ August ☐
   September ☐ October ☐ November ☐ December ☐

8. How would you describe the habitat in which you saw the hedgehog?
   Garden ☐ Hedgerow ☐ Scrub ☐
   Deciduous/broadleaf woodland ☐
   Coniferous woodland i.e fir/pine ☐
   Playing Field ☐ Open pasture ☐
   Arable/Tillage ☐ Road verge ☐
   Wet grassland ☐
   Other (please specify) _____