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Trialling amphibian ladders within roadside gullypots in Angus, Scotland: 2014 impact study

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ABSTRACT - Gullypots (roadside drains) have long been a problem for amphibians and other animals as a source of entrapment and certain death. Where the problem prevails close to migration routes for amphibians, the threat to local populations is significant and can devastate numbers each breeding season. Combined with existing known threats such as road death, road salting, agrichemicals, pollution and habitat damage, the dangers of gullypot entrapment can further imperil local populations to an unsustainable level. In the first UK trial of its kind, this study aimed to mitigate the gullypot problem with the installation of a simple ladder device which can be tailored and retrofitted in all circumstances. The authors adapted a design, trialled it in a known problem location and recorded findings. This study aimed to determine if the ladders can be ascended by UK widespread species, demonstrate the effectiveness of the amphibian ladders and quantify the extent of the problem using a robust dataset.

INTRODUCTION

Amphibian population levels continue to be threatened by the fragmentation of their habitats (Beebee & Griffiths, 2000). Development of roads and railways and continual urban growth cut right through the range of habitats the animals require (Beebee, 2013). Declines in frog populations showed significant correlation to the increase in human population density, as well as agricultural intensification and use of pesticides (Beebee, 1973 & Cooke, 1972). It is well known that toads (*Bufo bufo*) travel great distances to return to traditional breeding sites from hibernation and foraging grounds. Individuals continue to move to foraging grounds throughout late spring and summer (May to September) and then return to hibernation habitat in autumn (Buckley & Cole, 2004). Amphibians migrating to breeding or hibernation sites may be forced to cross roads where they are killed in large numbers (Fahrig et al, 1995) or follow kerb lines and crawl over numerous roadside drains (Smith & Sutherland, 2014).

Whilst performing standard drain maintenance during 2008/2009, Tayside Contracts staff observed animals, notably amphibians, trapped within roadside gullypots (Muir, 2011). The predominant species found was common toad (*B. bufo*) but also frogs (*Rana temporaria*) and palmate newts (*Lissotriton helveticus*). Perth and Kinross Countryside Rangers began to survey a variety of locations within the region and discovered that this was not an isolated problem. These initial observations instigated the formation of the Amphibians in Drains Project within Perth and Kinross (Muir, 2011). This three-year project (2010-2012) studied the extent of the problem within the Perth and Kinross area at a variety of sites. From the 1500 gullypots surveyed over this time period, approximately 3000 animals were found trapped. If this number is projected to represent the number of gullypots across the country, the rate of mortality throughout Scotland is significant (Muir, 2013).

The design of the drains allows no escape once the animal has fallen in which results in death by either starvation or drowning (Muir, 2012). Gullypot liners are used throughout the United Kingdom. These are installed below the tarmac to collect debris from the wash off of roads, removing water and preventing debris from clogging the sewage system. As gullypots are fitted with grid covers constructed with widely spaced bars, they allow no protection to amphibians walking over them and result in the animal falling within the gullypot (van Diepenbeek & Creemers, 2012). There has also been speculation that some amphibians may intentionally enter gullypots, mistaking them for ponds.

The gullypot drainage system is in most cases enclosed. In the gullypot wall, there are two ports leading to a chamber. The lower port allows run-off water to pass, the upper port is for maintenance access (rodding point) and is usually fitted with a plastic plug. Amphibians can enter the chamber through the lower port if it is below the water line, or through the upper port if the cover is loose or missing. In both cases, the amphibian is then prevented from travelling further into the system as the chamber itself has sheer sides which cannot be negotiated unless the gulleypot and chamber are fully flooded. In this case (during very heavy rain for example) any amphibians entering the chamber may be swept in to the carrier pipe which connects the gullypots. In the urban environment, most gullypot carrier pipes are fed to the sewer system, which is generally toxic and also has no further escape route. In some cases, the carrier pipe will lead to either a chamber or series of chambers, which have upstands of 150mm or to a soak-away system, either a tank or a gravel trap. In these circumstances, there is no further escape route for amphibians and other trapped animals. In rural situations, the carrier pipe may run into roadside ditches.

Because gullypot liners are normally manufactured using plastic, the resulting product is effectively a large diameter pipe (450mm) and when installed vertically, the sides are either smooth and sheer or corrugated, presenting no opportunities to escape. This results in any trapped animals suffering a lingering death from exhaustion, starvation and/or drowning. During the breeding season, this trapping potentially reduces the adult population of breeding males and females, possibly impacting on the success of local amphibian populations. Installing a ladder provides a means for the amphibians to escape and continue migration (van Diepenbeek & Creemers, 2012).

A variety of measures to reduce amphibian road deaths have been introduced globally (Smith & Sutherland, 2014). In Germany, two sites with significant numbers of migrating amphibians crossing the roads were closed on key migration evenings (Smith & Sutherland, 2014). Wildlife kerbs have been introduced into Perthshire (Muir, 2013). In north Wales, roadside drains in a sensitive Great Crested Newt habitat were moved so there was a 10cm gap between the kerb and the drain. This study showed an 80% decrease in the amount of newts found within the gullypot (Smith & Sutherland, 2014).

A non-governmental organisation, Reptile, Amphibian and Fish Conservation Netherlands (RAVON) conducted lab based studies to determine whether amphibians would use ladder structures to escape from water filled tanks. The trials were successful and Raymond Creemers presented their findings at the 2014 Herp Worker's Meeting in Bristol, UK. Trevor Rose, one of the present authors and founder of Friends of Angus Herpetofauna, was encouraged by the research performed by RAVON and began planning a trial installation of the ladders within the Angus area. After approaching Angus Council, he was granted permission to install ladders at two sites in Angus which had previously been noted as problem areas for amphibians in drains. 12 drains were identified at Station Road in Carnoustie and 38 drains were identified in Silver Birch Drive, Dundee. The study site, Silver Birch Drive (NO 446 343), is part of a relatively new housing development on the outskirts of Dundee. It is located adjacent to a golf course, which incorporates a variety of ponds that constitute ideal breeding sites for amphibians.

Local residents had previously applied to register the site as a toad migration crossing under the "Toads on Roads" scheme, as a result of observations of the increasing numbers of road-killed amphibians during peak times of migration. Toad warning signs were erected for this purpose. In recent years, anecdotal accounts from a number of residents suggest that the amphibian populations are dwindling. The amphibian ladder study focused on toads and frogs. Palmate newts (*L. helveticus*) were not found during this study but have been recorded in previous years within the study area.

MATERIALS AND METHODS

The study site is approximately 0.7 miles (1.13 kilometres) from drain 1 to drain 38 (Fig. 1). The RAVON ladder design (perforated steel plate) was modified by utilising a length of plain stainless steel which provided a structure for climbing material to be applied. The ladders were made from 125mm wide x 1mm thick stainless steel plate. This was cut to length to suit individual gullypot depth. A foot was formed at the base of each plate by bending a 20mm wide flange at right angles to the plate. At the top of the ladder, the plate was bent in a semi-ellipsoidal curve. Along both edges of the ladder where it is straight, the edges were flanged to provide stiffness. Enkamat®, the climbing material of choice, was not available in small quantities for the trial therefore jute (hessian) was used as a substitute. It was accepted that this would have a limited service life but it was expected to last for the duration of the trial (approximately six months). The jute was affixed to the steel using push-fit plastic clips.

Prior to the manufacture of the trial ladders, measurements of the gullypots were taken. Each gullypot was measured from the road surface to the full depth of the drain (where possible). In some instances, there was a significant amount of collected substrate, so the measurement was taken to the most firm point which would support the ladder. The height of the collected water was also measured relative to the overall depth, and the gullypot grating was measured for thickness. With these dimensions, the length of steel required could be calculated and the amount of jute determined. Ladders were then custom-built and labelled to suit each gullypot (Fig. 2). Manufacture of each ladder took around 15 minutes.

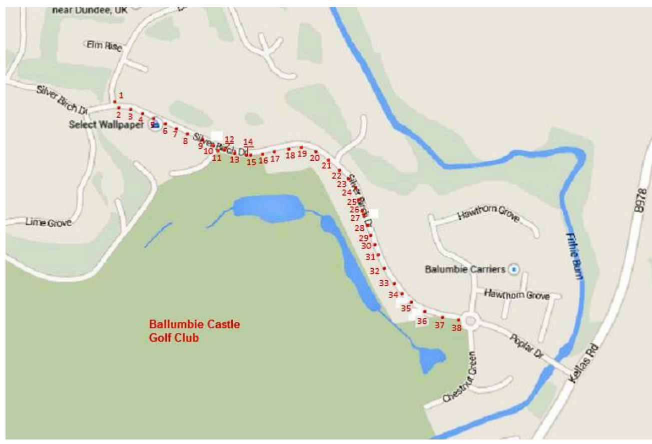

Figure 1. Silver Birch Drive street map showing gullypot locations. sourced from Google Maps (accessed online 29/03/2014) and annotated by McInroy, C.

Figure 2. Selection of trial ladders. Photo credit: Rose, T.

Installation of the ladders took place on the 5th March 2014. The ladder was installed such that the foot was positioned at the perimeter of the gullypot liner, and the top of the ladder then rested against the opposite side underneath the gullypot cover. It was important for the top of the ladder to be level and flush underneath the cover, and where possible, aligned with the gullypot cover grating bars (Fig. 3). This maximises the ease of escape for amphibians. At Silver Birch Drive, the gullypot covers were 50mm thick, which still needs to be negotiated by liberated specimens.

Figure 3. Ladder installed within a gullypot. Photo credit: Rose, T.

For the trial, two thirds of the drains were fitted with ladders and the remaining third had no ladders, and would be used as comparisons for the study. Un-laddered gullypots were evenly distributed through the site, such that every third gullypot had no ladder fitted. The study took place over three months. Daily visits to the site were undertaken for the first six weeks (05/03/2014 to 16/04/2014). These were usually performed at dusk to witness peak activity. Visits to site continued after 16/04/2014 to monitor the site and continue collecting information on the number of amphibians found within the drains. Seasonal movement had slowed by this point so daily visits were no longer required. The data analysed within this report were from the first six weeks of daily visits beginning from the date of ladder installation.

Each gullypot was visually checked using a powerful lamp to observe any signs of movement. Where large amounts of debris obscured the view, the covers were lifted to ensure no animals were hiding under the leaf litter. Amphibians found in the gullypots without ladders were immediately removed using an amphibian net or gloved hands (since there is no means of escape, it was not necessary to leave them in situ), whereas those in laddered pots were left in situ after they had been identified. Unique markings on each amphibian were used as identification. This method was found to be satisfactory since numbers of individuals in each gullypot at any one time were low, and only required to be monitored for a short period over a few nights. Once noted, individuals in laddered gullypots were then monitored to record whether they later escaped from the drain or remained for a period of time. Where individuals were not attempting an escape after several days, they were removed, recorded, and released in one of the golf course ponds.

RESULTS

Effects of ladders on escape success

In total over the six week period 247 frogs and toads were recorded in gullypots in the study area. One hundred and fifty eight amphibians fell into the 25 laddered gullypots (97 toads and 61 frogs, averaging 6.32 animals found per drain). The 13 gullypots with no ladders entrapped 89 amphibians (73 toads and 16 frogs, averaging 6.85 per drain). Forty-three amphibians were manually rescued from the laddered gullypots (26 toads and 17 frogs), while 115 used the ladders to escape (71 toads and 44 frogs). The number of amphibians that successfully ascended the ladders and escaped (115) represents 72.8% of the total number that fell into laddered gullypots (158). For toads, the percentage rescued was 73.2% (71 of 97, all males), and for frogs, the percentage rescued was 72.1% (44 of 61, including 11 females). There was a substantial variation in numbers of animals entering gullypots, from none at all (10 pots) to 37 in drain number 23. No dead amphibians were found within the drains throughout the study period. The average temperature from 5/03/2014 to 16/04/2014 when performing surveys was 6.5˚C. There was no significant rainfall during the study period and water levels in the gullypots remained unchanged.

Observations

The jute provided a suitable grip for the animals to climb relatively vertical ladders. There was initial concern that the ladders may prove too steep but this was not the case (Fig. 4). *B. bufo* sometimes took a relatively long time to begin ascending the ladders and the duration of the ascent itself could be lengthy. It is not clear to what extent the temperature is affecting this behaviour and the time taken, although logically we would expect slower motion in early spring temperatures of less than 8˚C. Most trapped amphibians tended to swim continuously around the perimeter of the gullypot at the water's surface. If the ladder was not within easy reach of the perimeter the animals frequently passed by without attempting to approach it, seemingly oblivious to its presence. Ladder positioning is therefore crucial.

Figure 4. Common toad, *B. bufo* on escape ladder. Photo credit: McInroy, C

Trapped amphibians were not inclined to attempt escapes when the temperature was very low. This resulted in some individuals spending many days in gullypots if they fell in just prior to a cold spell. Amphibians, especially newts, will use floating items as rafts if they are present. Providing a "raft" in the form a small piece of wood or other material could decrease mortality by offering a refuge if, for example, the temperature drops and until the animal is urged to seek an

Figure 5. Ladder design to be used in continuing 2015 trials, fitted with Enkamat® and raft. Photo credit: Rose, T.

escape. This will be trialled during 2015 (Fig. 5).

We did not see any toads in amplexus using the ladders, nor did we observe any frogs performing an escape. However, on several occasions frogs were witnessed sitting on the tops of ladders but when illuminated by torch they would jump off back into the gullypot. It is possible that as the frogs are more agile and flighty, they are more likely to find the escape route immediately and escape before they can be recorded. RAVON reported that some common frogs and edible frogs (*Pelophylax esculenta*) escaped using ladders with ten minutes of laboratory trials beginning. Fig. 6 shows a *R. temporaria* using a pry bar as a ladder that was being carried within the collection bucket. For this reason, we consider the overall results of this study and the data collected to be conservative, as it was not practical to attend the site around the clock (nor all parts of the site simultaneously) so the actual total number of escaping amphibians, especially frogs, cannot be quantified, but is likely to be higher than presented in the recorded data.

Figure 6. Frog using pry bar to escape from the collection bucket. Photo credit: McInroy, C

Figure 7. Leaf litter and debris build-up at the ladder top, which facilitates easier escape through the grating. Photo credit: Rose, T.

Female toads were not recorded escaping from the drains whereas female frogs were. It was unclear if this was due to the climbing material being inadequate to support gravid females or if their ability to ascend was compromised by their condition, or perhaps both. It is possible that the change of material to Enkamat® would improve the escape rates as it provides surer footing. Amplexing pairs had more difficulty in the drains and it is possible that the ladders will be of no benefit to them. This suggests that despite male toads being able to escape there is still the concern that local populations will be compromised due to the continued loss of females. It was often observed that when females were present within the drain, males were more intent on competing for females and coupling with them than attempting an escape via the ladders. However further trials with the Enkamat® product will be required to fully assess suitability for female toads and amplexing pairs.

The small cross-sectional area of the ladders and unobtrusive nature of the construction and installation had no detrimental effect on drainage. During the study, gully cleaning took place, which removed much of the substrate from the gullypots. This resulted in some of the ladders not fitting (no longer reaching the gullypot grating as they were too short) and these were remade accordingly. However, this activity did provide positive feedback from the operators, who reported that the ladders presented no issues for maintenance and refitting after cleaning was a simple operation.

DISCUSSION

Our study showed that ladders reduced entrapment in the gullypots at the study site. Evidently certain drains posed the greatest problems to amphibian migration. Poplar Drive leading onto Silver Birch Drive is the only access into this extensive housing estate. To reduce traffic speed, traffic calming chicanes have been constructed. These provide additional difficulties for amphibian movement. Drains 23 and 36 are within the corners of these chicanes and showed high numbers of trapped amphibians.

The depth of the grating was a cause for concern as this had to be negotiated by escaping amphibians. Male common frogs will usually grow to a body length of approximately 6.5 cm with females slightly larger at up to 8 cm (Beebee & Griffiths, 2000). Female *B. bufo* in the UK can attain 9 cm in length, with males measuring up to 7 cm (Beebee & Griffiths, 2000). These lengths suggest that many toads and frogs will be able to climb out despite the depth of the drain grating. Debris and leaf litter collecting on the landing area of the ladder can also facilitate escape (Fig. 7). The trial revealed a problem with substrate at the bottom of the gullypots requiring some ladders to be remade after gullypot cleaning. It would be beneficial to request the local authority to clean gullypots prior to manufacture of ladders if this study is repeated elsewhere. Once installed in a clean gullypot, substrate build-up causes no further issue as the ladder is self-standing and unaffected by the substrate around it.

CONCLUSIONS

The recorded data and observational evidence suggests it is possible to reduce the number of amphibians trapped during the breeding season within road drains by installing amphibian-friendly ladders. Once hot spots are identified (i.e. gullypots with high catch rates) the appropriate prevention should be introduced. This will minimise amphibian mortality and allow future surveying at new sites. The continued eradication of hot spot traps may help to ensure the future of amphibian populations. The average number of animals found in the drains without ladders was 6.84 compared with 1.72 in laddered drains that were manually released. This shows a significant reduction when ladders were present. Using the combined escape rate of 72.8%, we could expect that 180 of the 247 amphibians recorded may have escaped from the study area (during the period 05/03/2014 to 16/04/2014) if all gullypots had been protected by ladders.

Toad population size for this location has not been determined, so we are unable to assess the effect that on-going annual mortality due to gullypot entrapment is having. However, we estimate the breeding population to be between 1000 and 2000 individuals. Our assessment of the landscape suggests that the majority of the amphibian population migrates from the north and north east, and must cross Silver Birch Drive to reach breeding pools. The 153 entrapped toads during this 6-week study may represent a significant proportion of the breeding population, and mortality is further exacerbated by road casualties due to traffic (unrecorded data). Anecdotally residents have noticed a decline in toad numbers in recent years and this is also the view of the authors based on numbers recorded between 2009 and 2013. Potentially, this rate of gullypot mortality alone may not be sustainable at this site, for example, simplistically the 153 toads trapped represents 7.65% of a 2000 strong population. Based on this reduction year on year, the population would fall to less than 500 in two decades. Since many more toads would be trapped throughout the year, and other threats including road traffic are affecting them, the population may be in danger of local extinction without mitigation.

The long term aim of this project is to inform local authorities, councils, housing developers, road construction companies etc. on the importance of installing escape methods in drains for amphibians where there are significant populations and / or close proximity of breeding pools. After identifying the numbers of animals trapped within the pits under cattle grids, it is now common practice to provide 'hedgehog ramps' for escape. It is hoped that this study will have similar success. The costs to manufacture the trial ladders amounted to around £10 each, but this could be reduced significantly with mass production. It is essential to try and prevent anthropomorphic activities from influencing the decrease in amphibian populations. The Nature Conservation (Scotland) Act 2004 stipulates that local authorities have the duty to encourage biodiversity conservation within their area (Scottish Government 2004).

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