A Comparison of the body sizes of Common toads *Bufo bufo L.* at two sites in Cambridgeshire, one with a Toad Patrol and one without

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ABSTRACT - Common Toads *Bufo bufo* are declining in Britain and other areas of their range and road mortality is thought to be a contributing factor. In some areas, particularly in Europe and North America, 'toad patrols' have been set up to transport toads across roads during the breeding migration with the aim of reducing road mortality. This study measured body sizes of toads at two sites in Cambridgeshire, England, one with a long term toad patrol and one without, to determine whether the population at the patrolled site had a larger mean size because some individuals had been enabled to survive for longer. No significant difference in body size was found between the two sites, suggesting that mortality induced by factors other than traffic kill may be operating on the population and/or growth and that ultimate body size may be constrained by other environmental factors, which are not affected by toad patrols.

INTRODUCTION

Common Toads *Bufo bufo* are recognised as being of principal importance in Britain for the conservation of biodiversity under section 41 of the Natural Environment and Rural Communities (NERC) Act 2006 and were listed as a UK Biodiversity Action Plan species in 2007. However, they are still declining at present (Beebee, 2014). Amphibians can be particularly vulnerable to road mortality as they are often slow moving (Eigenbrod et al., 2009) and are believed to lack any behavioural ability to avoid roads (Eigenbrod et al. 2009; Beebee, 2013). In experimental tests many amphibian species stop moving when sensing engine noise and headlights of an approaching vehicle (Beebee, 2013).

In addition to the above factors, the vulnerability of *B. bufo* to road mortality is further increased by the species high terrestrial mobility, high migratory activity and breeding pond fidelity (Hels & Buchwald, 2001; Sutherland et al., 2010; Garriga et al., 2012; Beebee, 2013). Road mortality largely occurs during the breeding migration (Cooke, 1995; Meek, 2012) when as much as 100% mortality has been recorded (Semlitsch, 2003). The toads will not necessarily migrate through natural cover, such as rough grassland or scrub, to the breeding pond and often use open ground and roads, probably as a result of having few natural predators.

In many European countries *B. bufo* has the highest rate of road mortality of the amphibian species present (Santos et al., 2007) and the majority of amphibian road mortality research so far has been conducted on this species (Beebee, 2013). National authorities, non-governmental organisations and volunteer groups in Europe and North America manage mitigation measures against amphibian road mortality in the form of patrols and/or tunnels (Puky, 2005). Patrols consist of volunteers who collect and carry animals across the roads and release them at the breeding pond. A return procedure may also be in operation, returning animals back to the other side of the road after spawning has taken place. Patrols are most often used in species where a mass migration to a breeding site occurs, such as with some toad and salamander species, making hand collection effective. Tunnels are a permanent fixture under the road surface, intended for use by amphibians to and from the breeding migration and may be used by species which migrate in large numbers and also by those which do not.

The charity Froglife coordinates the toad patrol groups in Britain, providing advice and support to volunteers and managing a database of crossings and patrol data through the 'Toads on Roads' campaign, which was started by Flora and Fauna International in 1984. Many local Amphibian and Reptile Groups (ARGs) are involved in toad patrols. In Britain in the 1980s there were over 400 patrols, which between them moved more than 500,000 amphibians (mainly *B. bufo*) (Langton, 1989 in Beebee, 2013). By 2000 there were almost 900 patrols, which were moving a much reduced 100,000 toads (Froglife, 2012). The percentage killed averaged around 10% of those arriving at the road. For 2013 Froglife received patrol data from the largest number of patrols so far, with 141 returning data. In 2013, 80,923 were collected (and 7,327 reported dead) (Sivanesan, 2014). These numbers would seem to reflect what Beebee stated in 2014, that *B. bufo* has been and still is in decline in the UK.

After several anecdotal reports of toad populations where the adults were all noticeably small, a partnership between the Amphibian and Reptile Conservation Trust (ARC) and Amphibian and Reptile Groups UK (ARG UK) ran the first 'Toadsize' survey in 2013, a citizen–science project aimed at determining whether road mortality was preventing adults from reaching their full size. A total of 750 toads were assessed at 19 sites, with information about site locality and

the toad patrol recorded. The preliminary 2013 results have so far shown no difference in sizes either with or without a patrol or with or without traffic. However, patrol frequency and the distance of the road from the pond were found to be highly significant and associated with larger toads. A higher patrol frequency was associated with a greater size range of toads and the average size of toad is greater where the pond is further from the road (Inns, 2014).

The work reported here describes a similar study, carried out as part of the requirements for the M Sc degree at the University of Birmingham. The hypothesis being tested is that as road mortality may result in the death of a high percentage of the adult breeding population during the breeding migration, a regular patrol may prevent road mortality for a number of these individuals and so extend their lifespan, compared to a population similarly crossing a road and with no patrol. Because growth in toads continues throughout life, longer average lifespans should result in larger average body size.

METHODS

Study Sites

The body sizes of toads were sampled at two breeding locations in west Cambridgeshire, England. The first site in the village of Bourn (TL333592, 533380E, 259272N) was the pond at Great Common Farm on the Broadway road. This site had no current toad patrol and as far as could be ascertained has never had one. The second site had a voluntary toad patrol which has been in continuous operation since 1988. The patrol collect the vast majority of the breeding population through a combination of intensive searching and the use of temporary fencing, which keeps toads off the road until they can be collected. This pond was located at Madingley Hall (TL395604, 539499E, 260499N) on the High Street in the village of Madingley. Both ponds were located approximately 20 – 30 metres from the road. The surrounding areas of the ponds were composed of broadly similar habitat type, predominantly pasture with patches of scrub and hedgerow.

Sampling Method

The roads and surrounding areas of the ponds were surveyed for toads after dusk during the breeding migrations of 2013 and 2014. Survey dates were 11th April to 24th April 2013 and 18th February to 19th March 2014. All adult toads located were collected into buckets. Single females and amplexed pairs were kept in a separate bucket from single males to avoid fighting or smothering of the female. Toads which were incoming to the pond (pre-spawning) were kept in separate buckets from those which were outgoing (post-spawning).

At the end of the session at each site the collected toads were weighed (to the nearest gram) on a standard electronic scale (Duronic) and measured (to the nearest mm) from snout to urostyle. Four variables were recorded – female body weight (FBW), male body weight (MBW), female body length (FBL) and male body length (MBL). As there is some body weight loss after spawning in both sexes, whether the toad was pre or post-spawning was also recorded. This allowed only toads of the same state (and sex) to be compared.

The toads were then released either at the pond or on the other side of the road, depending on the direction of travel. To avoid the transmission of disease (such as Chytrid fungus) between sites the equipment, boots and hands were cleaned with a bleach based spray (Morissons Kitchen Spray with Bleach) and rinsed off thoroughly.

Analysis of Field Data

Data of body lengths and weights were first tested for normality using the Anderson-Darling test, which indicated 4 of the 8 data sets were not normally distributed. Subsequently, non-parametric Mann-Whitney U-tests (Minitab, v17) at n_1-1 + n_2-1 d.f. were used in the test for effect of site (patrol versus no patrol) on the median values of toad body lengths and body weights (pre-spawning toads only).

RESULTS

A total of 278 toads were recorded across the two sites, 178 in 2013 and 100 in 2014. No significant differences between years were found for any of the four variables, female mean body length (FMBL), female mean body weight (FMBW), male mean body length (MMBL) and male mean body weight (MMBW) and so the data for each of these variables for the two years have been combined. Table 1 shows the combined data, together with the results of Mann-Whitney U-tests for comparisons between medians. None of the differences were significant.

	Madingley (Patrol)	Bourn (No Patrol)	W	d.f. (n-2)	P
Females					
FMBL	72.6 (72)	73.1 (72)	3789.5	100	0.82
FMBW	43.3 (41)	45.3 (46)	3619.5	100	0.30
Males					
MMBL	59.7 (58)	60.1 (61)	11405.5	174	0.26
MMBW	22.7 (21)	22.6 (22)	11386.5	174	0.29

Table 1. Female mean body length (FMBL), female mean body weight (FMBW), male mean body length (MMBL) and male mean body weight (MMBW) for toads at Madingley and Bourn. Numbers in parenthesis show median values with W the Mann-Whitney statistics for tests of differences between medians. Data for 2013 and 2014 combined.

DISCUSSION

The results comparing body length and weights of toads between the patrolled and unpatrolled sites were not significant, meaning the null hypothesis could not be rejected. No significant difference in the lengths or weights of toads between the patrolled and unpatrolled sites was found. It is possible that there was a difference in the quality and quantity of food items between the sites. In theory better feeding conditions at Bourn could have enabled the toads there to have reached the same size as those that were enabled to grow larger at Madingley by virtue of a toad patrol effect but this seems unlikely. The terrestrial habitat within 1000 m of the

breeding ponds (the typical migration range) was varied, with a larger proportion of mature woodland at Madingley and more rough grassland at Bourn. Both are favoured terrestrial habitats for common toads.

A previous study (Inns, 2014) also found no significant difference in sizes of toads from populations with or without patrols, but it did find that larger toads were significantly correlated with patrol frequency. The Madingley site is patrolled frequently - almost constantly during the breeding migration and return journey - but this study did not find larger toads there. The Inns (2014) study also found a greater size range at patrolled sites: this again was not evident at Madingley. If patrolling did exert an effect on toad body size, it could be argued that it should be evident at the Madingley site where there has been a continuous patrolling effort since 1988. The combination of intensive collection and temporary fencing means that relatively few toads succumb to road mortality during the breeding migration at this site.

One possible explanation for the results recorded here is that that toads at Madingley are experiencing a high adult mortality due to factors other than road mortality during the breeding season. A low annual survival rate for *B. bufo* has been documented, with many surviving for just a single breeding season (Gibbons & McCarthy, 1984; Kuhn, 1994; Scribner et al., 1997, cited in Brede & Beebee, 2006). Gittins (1983), Gittins et al., (1984) cited in Beebee (1996) and Hemelaar (1984) cited in Beebee (1996) found that adult male survivorship between years to be 0.52 and for adult females 0.40 (the lower survival of the female was thought to be due to the increased burden of egg production). Scribner et al. (2001) found an even lower annual survival of adult toads, of under 15% and under 5% at two sites in England.

Changes in survival of adult and juvenile stages is thought likely to drive amphibian population dynamics as typically these stages have higher survival than earlier stages (Biek et al., 2002). Franz et al. (2013) found that road mortality of adult Natterjack Toads *E. calamita* in Poland was a key process affecting the dynamics of the meta-population. The majority of previous amphibian research has focussed on embryo and larval survival. Very little is known about the effects of road mortality on juvenile amphibians. It would be beneficial to have an increased focus on other life history stages to identify which are the most sensitive to the driver/s of a species decline. Targeted conservation efforts may then be enacted more widely.

In the face of declining amphibian populations, toad patrols are arguably worth pursuing even if most adults experience only one breeding season. Although Beebee & Griffiths (2005) suggest that the chances of reversing amphibian declines seem poor, as the threats are complicated and difficult to mitigate against, patrols are likely at the very least to increase the chances of more toads spawning at least once in those areas affected by road mortality, even if they do not increase individual toad survivorship longer term. Further research on the effectiveness of toad patrols on the lifespan of toads and the overall population size would be useful in determining future conservation measures for this declining species. This comment is speculative and the results of this study must be regarded as preliminary, and as with much work in applied ecology, they highlight the need for further research.

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