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The role of road traffic in the near extinction of Common Toads (*Bufo bufo*) in Ramsey and Bury

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Since the 1980s, Common Toads (*Bufo bufo*) have decreased over much of central, southern and eastern England (Hilton-Brown & Oldham, 1991; Carrier & Beebee, 2003). Cooke & Sparks (2004) studied three declining toad populations in Ramsey and Bury in Cambridgeshire, and concluded that road traffic had contributed by killing migrating adults. It was further suggested that unsustainable mortality on roads might be a factor contributing to declines of Common Toads more generally. This suggestion was supported by detailed fieldwork on various anuran species in Canada (Fahrig *et al.*, 1995) and Denmark (Hels & Buchwald, 2001).

Throughout the period of these population declines in England, there has been widespread concern about toads being killed on roads, and volunteers have carried them across many roads at times of peak migration (Langton, 1989, 2002). In Cambridgeshire, we have a particularly well-known, large scale initiative at Madingley that was started in 1988 (Seale, 2010). Despite the concern about road mortality, losses have usually been viewed as sustainable as regards conservation of populations (e.g. Gittins, 1983; Beebee & Griffiths, 2000). If levels of road traffic continue to increase, however, losses may eventually become unsustainable. Numbers of toads being killed are likely to increase in a situation where both a toad population and its local environment remain unchanged, apart from an increase in road traffic. Once losses become unsustainable, the population will decrease and so will numbers killed (Cooke & Sparks, 2004).

Study sites and methods

The toad breeding sites are in Ramsey and its attached village of Bury. Three principal ponds have been used by toads: Bury Pond (TL 282843), Field Road Pond (TL 283856) and Horse Pond (TL 292852). Each pond is about 1 km from the other two, and each is a traditional site that has held breeding toads for many years.

During the toad breeding season, brief daytime visits were made on most days to check when peak numbers of casualties appeared to occur. Then counts of casualties were made on foot during daylight on 12 nearby roads (see Table 1 for road names). If further significant mortality was noted, counts were repeated and the highest figure for each site was used for that year. This peak count will include an unknown proportion of the toads killed that year. Although avian scavengers such as Carrion Crow (*Corvus corone*) and Magpie (*Pica pica*) were rare in the area during the study period, casualties will have been lost before being counted due to factors such as wet weather and scavenging by mammals. Other toads will have been killed after the count was made, but road mortality on the return migration did not result in a marked increase in casualties. The

objective was not to count every casualty but to record systematically so that long-term trends in counts might reflect trends in total numbers killed. Casualties have been counted each year since 1990 on roads around Bury Pond, since 1984 beside Horse Pond and since 1974 at Field Road. This article is primarily concerned with the recent marked declines and focuses on the period 1990-2010.

Table 1. Traffic counts for the 12 roads, March 2004 and mean proportional annual change in road casualties, 1990-2004. Mean number of vehicles per 15 minute period is based on seven counts, one on each night of the week.

Road	Designation	Pond site	Vehicles per 15 minutes (mean ± SE)	Vehicles per hour	Proportional annual change in casualty counts
Field Rd	-	Field Rd	32.9 ± 2.5	131	-0.148
St Marys Rd	B 1040	Field Rd	32.1 ± 5.1	129	-0.097
Princes St	-	Field Rd	4.4 ± 0.8	18	-0.055
Star Lane	-	Field Rd	4.4 ± 1.4	18	-0.064
Station Rd	-	Field Rd	8.6 ± 1.2	34	-0.083
Ramsey Rd	B 1040	Bury	98.7 ± 11.1	395	-0.157
Grenfell Rd	-	Bury	10.7 ± 1.9	43	-0.105
The Malting	-	Bury	9.6 ± 2.6	38	-0.113
Upwood Rd	-	Bury	47.0 ± 6.1	188	-0.107
Biggin Lane	-	Bury	15.9 ± 2.3	63	-0.098
Brand Close	-	Bury	1.6 ± 0.4	6	+0.075
Wood Lane	B 1096	Horse	22.3 ± 3.9	89	-0.062

Observations on toads breeding in Bury Pond have been undertaken routinely since 1990 (Cooke, 2000), with daytime counts of adults being made during the breeding season every year. Observing events in Horse Pond was difficult because of the typically high turbidity of the water, but night counts of adult toads were undertaken in 2004 for comparison with earlier counts. No counts of adults were made in Field Road Pond because of very restricted access to the banks.

Between 5th and 27th March 2004, traffic data of relevance to toad migration was collected on the 12 roads. Between one hour after sunset and 22.00 hours, seven 15 minute censuses were undertaken on each road, with one on each night of the week. In 2004, the main toad migration occurred on the nights of 14th and 15th March. The amount of traffic on each of the roads relative to the others probably changed little during 1990-2004, so the 2004 data are used to reflect relative traffic intensities during that period. However, it is likely that road traffic has increased on all roads since 1990. An increase of 11% in the number of vehicles using the B1040 to the south of Bury was recorded between 1992 and 2002 (Cambridgeshire County Council, 2002).

Results and observations

At Bury Pond, casualty counts decreased between 1990 and 2010 (Figure 1, correlation coefficient $r_{19} = -0.660$, $P < 0.01$), as did counts of live toads in the water ($r_{19} = -0.789$, $P < 0.001$), and the two counts were also correlated ($r_{19} = 0.836$, $P < 0.001$). Live counts were zero from 2007 onwards. As declines in casualty counts at Bury Pond were synchronous with those at Field Road Pond (Figure 1, $r_{19} = 0.789$, $P < 0.001$) and Horse Pond ($r_{19} = 0.886$, $P < 0.001$), it seems reasonable to conclude that toad numbers decreased at all three sites during this period. This is supported by four night-time counts of live toads at Horse Pond: 145 in 1990, 262 in 1991 and zero twice in 2004. The combined total of casualty counts for the three sites decreased from a peak of 482 in 1991 to a single toad in 2010 (Figure 1). Four dead toads were noticed on other roads in Ramsey in March 2010.

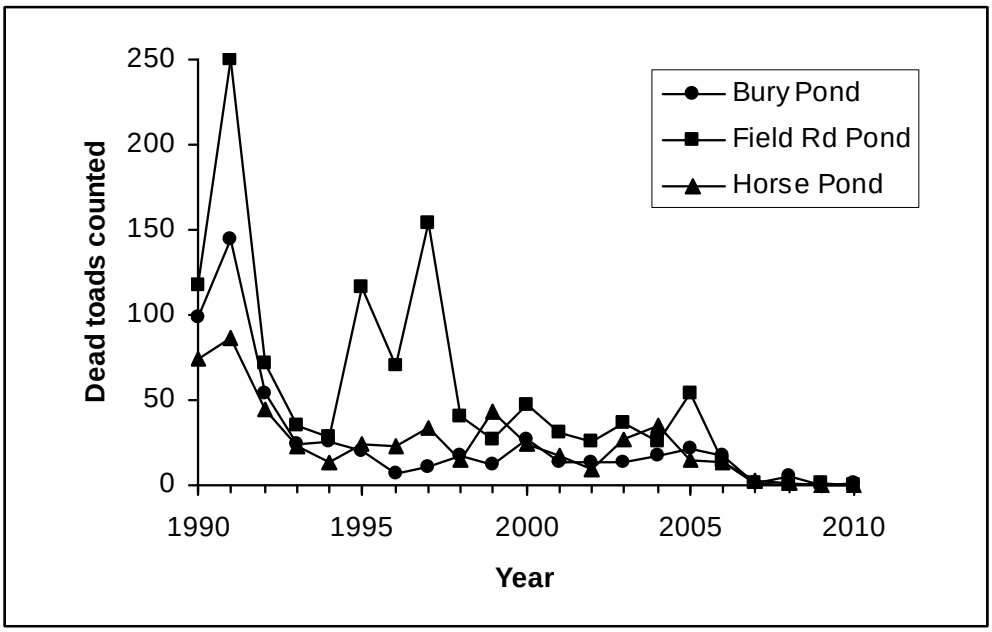

Figure 1. Casualty counts of toads on roads around the three ponds, 1990-2010.

Traffic census information is summarised in Table 1 as the average number of vehicles per hour. Lorries and similar-sized vehicles comprised only 0.5% of the traffic, so are not separated from smaller vehicles in the table. Motor cycles were not counted. The three B class roads and Upwood Road are the main roads into and out of the area. These four, together with Field Road, carried the greatest volumes of traffic. Field Road is one of Ramsey's busiest domestic roads. Traffic flow varied through the week (chi-squared = 81.0, d.f. = 6, $P < 0.001$) with the following total numbers of vehicles being counted during the 15 minute censuses on the 12 roads: Monday 273, Tuesday 300, Wednesday 289, Thursday 332, Friday 379, Saturday 267 and Sunday 177. Friday, the night with the most traffic, was more than twice as busy as Sunday, the night with the least activity.

Also included in Table 1 is the proportional annual change in casualty counts for each road, 1990-2004, calculated as in Cooke & Sparks (2004). There was a negative relationship between this measure and traffic flow rate for the 12 roads (Spearman rank correlation coefficient $r_s = -0.747$, $P < 0.01$), i.e. the rate of decrease in casualties tended to be greater on a road with more traffic.

Discussion

Numbers of toads counted dead or alive have been much reduced in Ramsey and Bury over the last 20 years. This article takes the story on another seven years from the data presented by Cooke & Sparks (2004). During this time, the situation has continued to worsen. Combined casualty counts at the three sites have not exceeded 10 since 2006. That a few casualties can still be found indicates limited breeding locally. Small numbers of toads still use the Field Road pond, but apparently remain close to it throughout the year and do not cross the roads (Peter Fearn, pers. comm.). It is possible that some toads migrate in from sites in the wider countryside (Cooke & Sparks, 2004; Cooke & Cooke, 2008).

Why then have toad numbers declined when all three breeding ponds are protected in different ways (Bury Pond is a Wildlife Trust reserve, Horse Pond is in a conservation area and the Field Road Pond is in private ownership)? Cooke & Sparks (2004) considered that although other factors were also implicated, such as loss and modification of previously suitable terrestrial habitat, unsustainable road mortality made a major contribution. Reasons for suspecting road mortality included:

- the pattern of casualties at the Field Road site since 1974 was consistent with increases in casualties as road traffic increased, until losses became unsustainable in the 1980s and casualty numbers came down reflecting a decreasing population;
- the model of Hels & Buchwald (2001) indicated that the probability of a toad being killed during a single crossing of Ramsey Road, Bury might be as high as 0.67;
- there was evidence that direction of migration was being modified with relatively fewer dead toads being found in later years on the busier roads.

This paper reports traffic flow rates on nearby roads in March 2004 during the toad migration season. A relationship was found between the rate of change of casualty counts and traffic intensity suggesting that the busier roads had a greater impact on numbers migrating. However, data for the 12 roads were not independent as what happened on one road may have affected what happened on others around the same pond. Moreover, in some situations toads had to cross more than one road to reach their pond. Nevertheless, adult toads can have a tendency to migrate to and from a breeding pond in a certain direction (Heusser, 1969; Haapanen, 1974; Latham, 1997; Oldham, 1999), and the observed relationship provides some support for the conclusion that road traffic had an appreciable impact. It should also be pointed out that a reduction in the number of toads migrating across a road does not necessarily mean that the breeding

population will be reduced as a consequence (e.g. see Oldham & Swan, 1991; Young & Beebee 2002). A population reduction is though more likely to occur if a pond is surrounded by roads. This is the situation at Bury Pond while the Field Road pond has roads on three sides and Horse Pond on two sides.

Whether overall losses on all roads are unsustainable is a more important conservation consideration than impact on just the busiest road. Numbers of road casualties have now decreased to virtually zero and it no longer seems worth continuing with the counting. Could, then, more have been done to prevent losses on the roads? The local Wildlife Trust first organised volunteers to carry toads across roads in Ramsey and Bury in 1987. This was initiated because of concern for individual toads, not because of concern for the population. By the mid 1990s very few volunteers remained, most having been deterred by the decreasing numbers of live migrant toads. Casualty numbers were not, however, particularly low in the mid 1990s, especially when compared with 1970s data from Field Road (Cooke & Sparks, 2004). In other words, the feeling was that toad lifting was not as productive as it had been. Concern for the populations did not start to materialise until several years later. With hindsight, the toad lifting operation should have been intensified when numbers began to fall away. Realisation that a population might be adversely affected by road traffic could stimulate more people to take part and help retain their commitment for longer.

This study in Ramsey and Bury appears to be the first to draw attention to the fact that the night of the week on which migration mainly occurs may also be important. Hels & Buchwald (2001) modelled the probability of a Common Toad being killed as a function of traffic intensity, taking into account observed diurnal variations in toad activity and traffic. Using their model, an increase in local traffic between Sunday and Friday nights could approximately double the number of dead toads. Local information such as this can help make volunteer patrols more effective.

Fahrig *et al.* (1995) reported fewer live or dead toads on roads with higher rates of traffic flow near Ottawa. Their observations were consistent with situations where road mortality had already considerably modified distribution and abundance. In western Cambridgeshire, the Common Toad has decreased in numbers over the last twenty years or so, and road mortality has probably contributed significantly. Widespread population declines of the Common Toad in Britain during the 1950s and 1960s were mainly caused by loss or modification of habitat (Cooke, 1972). Declines slowed in the 1970s (Cooke & Scorgie, 1983), but have become more obvious again since the 1980s in parts of central and southern England (Hilton-Brown & Oldham, 1991; Carrier & Beebee, 2003). This follow-up to the study of Cooke & Sparks (2004) does nothing to dispel concern that unsustainable road mortality may have contributed to this later wave of declines. If it can be a factor in this unremarkable rural area, then it can be a factor elsewhere.

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