MONITORING A BREEDING POPULATION OF COMMON TOADS (*BUFO BUFO*) IN A HOUSING DEVELOPMENT

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DURING the 1990s the subject of surveying and monitoring populations of the British amphibian species generated considerable interest (eg. see discussion about techniques in Griffiths & Raper, 1994; Griffiths, Raper & Brady, 1996; Griffiths & Inns, 1998). Authors have generally agreed that populations of the Common Toad (*Bufo bufo*) can best be surveyed by counting heads at night at peak breeding season. One problem encountered with toads is, however, that they often breed in large deep sites that present logistical or safety problems for the surveyor, especially at night. Partly as a consequence, day counting, spawn string estimation and road casualty counts have also been used (eg. Cooke, 1995; Cooke & Oldham, 1995).

An opportunity arose at the end of the 1980s to undertake an annual suite of observations on a toad population breeding in a pond in Cambridgeshire. The main aim as regards monitoring was to determine the usefulness of certain variables other than total night count. This exercise also provided the opportunity to determine whether retention of a breeding pond within housing could prove successful for a toad population, as it had for a population of Crested Newts, *Triturus cristatus* (Cooke, 1997).

SITE AND METHODS

In the mid 1980s, toads bred in three washing lagoons behind a vegetable packing plant in Bury, Cambridgeshire (grid reference TL 282843). Neighbouring housing had been built in the mid 1980s, in the 1970s and more than 30 years ago. The plant itself was pulled down and replaced by housing during 1988 and 1989. Part of the largest lagoon was safeguarded as a toad breeding pond within the new housing development, and was managed by the local Wildlife Trust. By 1989, however, this pond was totally surrounded by housing.

Final dimensions of the pond were about 25x15 m, with a terrestrial margin of about 5 m.

Site of breeding pond within housing development at Bury, Cambridgeshire. Photograph by A.S. Cooke.

Water level has remained fairly stable with the pond being recharged by run-off, but having an overflow pipe to the drainage system. Toadlet production occurs every summer but is variable. The whole site amounts to only about 0.1 ha, but toads migrate in to breed over distances of 500 m or more despite the constraints to movement posed by the new houses, roads, kerbs, fences, walls etc. The two nearest toad colonies to the site are more than 1 km away in the neighbouring town of Ramsey.

The modest size of the pond, that there was ready access around the edge and that the water was reasonably clear meant it was an ideal situation to visit regularly each spring to record the following peak counts: daytime and night-time counts for pairs and total numbers; road casualties on a circuit of 1.6 km including a 500 m length of the B1040. It should be stressed that the counts are not estimates of total numbers in the population, which remain unstudied; total numbers may be at least an order of magnitude higher than the counts (eg see Cooke & Oldham, 1995). A spawn string index was estimated for each year (Cooke & Oldham, 1995). This index was derived by probing the water's edge with a cane and counting what were considered to be individual strings or groups; the technique is intended to be used in a comparative manner and does not represent an absolute measure. Counts were also made of spawn clumps for the Common Frog (*Rana temporaria*).

RESULTS AND DISCUSSION

Results are summarised in Table 1. Initial data collected were casualty counts on the B1040 (toads on the rest of the circuit of roads were counted from 1990). Observations on the toads in the water began as development of housing started in 1988. Over the ten year post-development period, 1990-1999, few observations were missed. In some years spawn index was recorded as a range; in those cases the mid point of the range is given in Table 1. Finite estimates of toad spawn index were not available in 1991 (when visits later in the season were lacking) and 1992 (when some toads spawned in vegetation in the centre of the pond). The figure for spawn in 1992 was used in the ranking analysis below as it was the highest recorded; but that for 1991 was discarded. Illness prevented visits at night in 1999.

Spearman rank correlation coefficients (r_s) were calculated on pairs of variables considered to be ecologically meaningful; particular emphasis was given to peak total day counts which are most readily undertaken. Each of the first seven variables listed in Table 1 may reflect the true population trend over time and significant positive relationships between total day count and other variables would support its use alone to monitor population fluctuations:

Total day count vs casualties on the B1040, 1988-1999, $r_s = 0.745$ ($P<0.01$); vs casualties on other roads, 1989-1999, $r_s = 0.530$ (NS); vs casualties on all roads, 1989-1999, $r_s = 0.636$ ($P<0.05$); vs day pair count, 1988-1999, $r_s = 0.589$ ($P<0.05$); vs spawn index, 1988-1999, $r_s = 0.548$ ($P<0.05$); vs total night count, 1989-1998, $r_s = 0.806$ ($P<0.01$); vs night pair count, 1989-1998, $r_s = 0.567$ ($P<0.05$).

Day totals were positively related to a range of other variables and can clearly be used for monitoring. However, night-time totals tended to be higher (paired t test, $P<0.05$).

Casualty numbers on the two lengths of road were related to one another ($r_s = 0.806$, $P<0.01$), and casualties on all roads were related to total night counts ($r_s = 0.825$, $P<0.01$). Previously I have been cautious about using data on casualties to indicate population trends in another local breeding pond (Cooke, 1995), but at this site road casualties reflected numbers seen alive in the breeding pond. Spawn index was related to total day count, but was not significantly related to total night count or to day or night counts of pairs (P>0.05). However, it can be a valuable addition to day counts in sites that are difficult or unsafe to survey at night (Cooke & Oldham, 1995).

Turning to whether toad numbers have changed over time, the two longest data sets were for casualties on the B1040 and for total day counts. There was a significant negative relationship between the former and years (r_s = -0.779, P<0.01), but not for the latter (r_s = -0.420). A number of the data sets revealed highest numbers in 1991 after comparatively low numbers when the houses were being built in 1988 and 1989. Therefore examining data post-development seems a reasonable approach. Total day counts showed a significant negative relationship with time, 1990-1999 (r_s = -0.685, P<0.05); and a similar relationship existed for casualties on all roads (r_s = -0.867, P<0.01). Thus a decline in population level was confirmed for the 1990s. Regression analysis for total day counts and for casualties on all roads, each individually expressed as log (y + 1) against year, predicted that numbers will decline to zero in 2003 (SE, 2 years) or 2006 (4 years) respectively. So this toad population may become extinct midway through the current decade, a fact which has been drawn to the attention of the site managers.

In contrast, the frog population increased significantly during the post development period (r_s = 0.900, P<0.001). The increase in frogs and the decrease in toads were related (r_s = -0.693, P<0.05), suggesting that competition from frogs may be a factor in the decline in the toad population. However, other factors may also be implicated. The immediate area has changed dramatically in recent decades from a mixed rural and suburban landscape to a predominantly suburban one with relatively high density housing. Death on the new estate roads will have increased spring-time mortality. Construction of houses, fences and walls will have impeded movement to and from the pond;

Year	Dead B1040	Dead other roads	Total day count	Day pair count	Spawn string index	Total night count	Night pair count	Peak date	Frog spawn clumps
1986	33								
1987	18								
1988	8		43	2	25			108	0
1989	48		106	6	37	252	14	90	0
1990	26	72	145	11	50	240	12	72	12
1991	26	119	262	47	>15	434	75	73	1
1992	24	30	210	23	>70	184	25	82	10
1993	9	16	108	2	63	120	10	77	12
1994	8	18	29	8	55	83	9	68	17
1995	9	11	116	15	48	104	9	91	28
1996	1	6	60	5	35	98	6	105	13
1997	2	9	34	4	12	32	3	75	52
1998	1	16	30	8	25	59	16	67	32
1999	4	8	63	8	22			75	96

Table 1. Peak season counts for the toad colony, and cumulative spawn index for toads and number of frog spawn clumps, 1986-1999. The peak date is the day of the year when the highest count of live toads was made. Gaps indicate no data.

and may have caused increased isolation of the toads at this site and loss of genetic diversity (Hitchings & Beebee, 1998). Carrying capacity has presumably decreased as a consequence of the habitat changes; difficulty of access to suitable terrestrial habitat may be a greater problem than lack of habitat. While a reduction in carrying capacity may, in the short term, lead to a lower level of population, the probability of extinction is increased in the longer term (Halley, Oldham & Arntzen, 1996).

Dates of peak counts are given for toads in Table 1. These dates did not change significantly over the years 1988-1999 (r_s = -0.313), but they were negatively related to mean March temperature recorded at Monks Wood about 10km away (r = -0.782, P<0.01). At one of the other two local colonies, where road casualties have now been counted for 26 years, peak migration activity occurred earlier in the year in the 1990s and date was negatively related to temperature at Monks Wood (Cooke, 1995 and unpublished observations). One consequence of the toad season becoming earlier is that the gap between breeding by frogs and toads may be reduced, so increasing competition. Mixed mating pairs consisting of a frog and a toad were first recorded at the main study site in 1990, and then again in 1998 and 1999; in all three of these years, peak activity occurred relatively early in March. If male frogs mate with female toads, the reproductive potential of the latter will be lost for that year.

CONCLUSIONS

This study has shown that monitoring a toad population can be undertaken by recording a number of different variables, total numbers seen during the day at peak breeding season being as useful as any. At this particular site, toad numbers decreased despite part of the main breeding pond being safeguarded within a housing development. An increase in competition from frogs and changes in the terrestrial environment may be implicated in this decline.

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