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SHORT NOTE

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Farewell to the bottle trap? An evaluation of aquatic funnel traps for great crested newt surveys (*Triturus cristatus*)

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Aquatic funnel traps are an established technique for the capture of newts. In the United Kingdom they are widely used for commercial surveys of great crested newts (*Triturus cristatus*) to comply with EU regulations during land developments such as construction activities. The present study demonstrates that widely-used traps constructed from plastic bottles could become replaced by more efficient funnels such as collapsible nylon traps. To achieve this, we followed standard UK survey protocols to systematically compare bottle traps with nylon traps at six ponds with known *T. cristatus* occurrences in western France. Out of 296 *T. cristatus* records, nylon traps yielded 79.7% of all captures and 83.3% of all recaptures. Standardized population size class estimates based on capture numbers were equal to or higher using nylon traps than with bottle traps, and nylon traps outperformed bottle traps for more precise population size estimates based on capture-mark-recapture. We suggest that bottle traps could be replaced by nylon traps during standard surveys for aquatic newts in the UK and elsewhere.

Key words: Amphibians, crested newt, funnel trap, monitoring, *Triturus cristatus*

Monitoring and sampling programmes are the first steps in addressing the reasons for, and mechanisms of, declining amphibian populations (Collins & Crump, 2009). Funnel traps are one of the most often applied methods for quantitative sampling of amphibians during their aquatic phase, and come in a variety of shapes and sizes (see Dodd, 2010 and references therein). The northern or great crested newt (*Triturus cristatus*) still occupies large parts of central and northern Europe, but has been declining more rapidly than other newt species (Jehle et al., 2011). 'Bottle traps' made from plastic drinking bottles (Griffiths, 1985; see also Richter, 1995) are a widely used standard technique to sample *T. cristatus* during the aquatic phase (e.g., Griffiths et al., 1996; Jehle et al., 2000; Griffiths et al., 2010). In the UK, bottle traps are also specifically recommended by national best-practice guidance for standardized *T. cristatus* surveys (Gent & Gibson, 1998; English Nature, 2001; Sewell et al., 2013), and they are in wide use by commercial consultancies acting on behalf of land developers to comply with the European Habitats Directive (92/43/EEC) in the course of residential/industrial construction or mineral extraction. However, while bottle traps are cost and labour efficient to produce, they are associated with size constraints as well as inflexible bodies, and alternative trap types based on larger containers or mesh have become adopted elsewhere across the species' range (Haacks & Drews 2008; Bock et al., 2009; Drechsler et al., 2010; Kröpfli et al., 2010). Of particular note are nylon funnel traps, which comprise a collapsible, spring loaded wire frame covered with mesh and circular entrance holes at each end. These are widely available commercially from around £1.00 e.g., on internet auction sites such as Ebay; a price comparable to self-made bottle traps when taking labour and additional material costs (i.e. bamboo canes and tape for trap construction) into account. However, it should be noted that the quality of these traps may change depending on the manufacturer (Kupfer et al., 2006). This study aims to compare the efficiency of bottle traps with nylon traps in order to contribute towards a more efficient standardized capture method for *T. cristatus* in the UK and elsewhere.

The study was conducted in April 2012 and included six ponds in the Département de Mayenne (western France) which were known to support *T. cristatus* from previous studies (e.g., Jehle et al., 2005). Data collection largely followed the guidelines for standardized surveys in the UK (Gent & Gibson, 1998; English Nature, 2001), and involved a combination of torchlight counts and trapping over three nights for each trap type, in our case resulting in six consecutive nights of data collection at each pond (whereby bottle traps were used during survey nights 1/3/5, then nylon traps were used during surveys 2/4/6, and vice versa). None of the traps were baited. Trap installation took place between 1900 and 2300 hours, and traps were checked and emptied between 0700 and 0930 the following day. Traps were positioned at 2 metre intervals around the entire perimeter of the pond and trap positions were marked for consistency. Bottle traps were constructed from 2 litre plastic bottles

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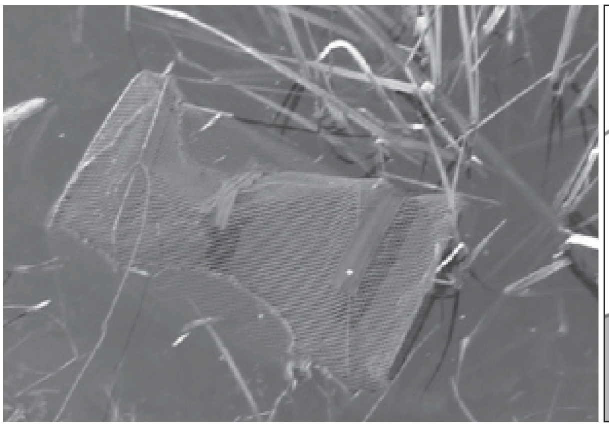

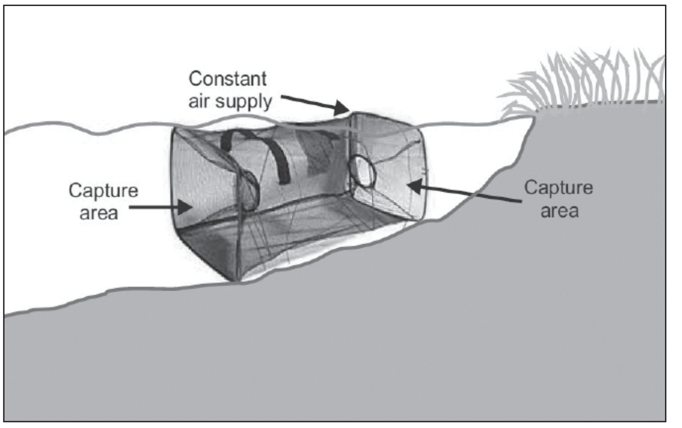

Fig. 1. Collapsible nylon trap *in situ*.

and fixed to the pond substrate with bamboo canes. They were positioned on the base of the substrate at an angle to ensure the presence of an air bubble inside the bottle without contact to ambient air. The nylon funnel traps had a metal frame size of 45 x 22 x 22 cm covered with 3 mm green mesh nylon webbing and 6 cm holes at each end; elastic bands were secured between the entrance holes to maintain a funnel shape. In order to provide constant access to air the net was placed or secured so that part of the net emerged from the water (Fig. 1).

We used *T. cristatus* capture numbers summed across the three nights of data collection (although elsewhere at least six visits are advised for this assessment, Sewell et al., 2013) to assess population size classes for each pond (i.e. 'small': <10 captures, 'medium': 11–100 captures and 'large': >100 captures). To obtain more precise estimates of population sizes, we adopted a capture-mark-recapture approach using Begon's weighted mean (Begon, 1979); individuals were group-marked using toe-clipping and we treated each inspection of traps as a single sampling session. Toe-clipping was chosen due to its practicability (see Perry et al., 2011 for a general discussion), and because there is no indication that it has harmful effects for *T. cristatus* (Arntzen et al., 2000). Measures for newt activity obtained from the two trap types were estimated as number of newts*100/number of traps*12 hours (following Schlüpmann & Kupfer, 2009; the traps were deployed for approx 12 hours in each sampling session).

A total of 426 traps of each type were deployed (between 10 and 48 traps at each pond depending on shoreline length) and no mortality was observed inside the traps. Across all ponds, a notably higher number of nylon traps (138, 32.4%) captured at least one individual *T. cristatus* when compared with bottle traps (44, 10.3%); yielding 236 and 60 records, respectively (Table 1). Average peak counts per survey across all six ponds were 16.33 using nylon traps and 5.5 using bottle traps (minimum/maximum counts for nylon traps and bottle traps were 1/43 and 1/19, respectively). Average newt activity measured across all ponds was 1.85 for bottle traps (averaging between 0.19–6.11 over three surveys depending on the pond) and 7.28 for nylon traps (averaging between 0.37–21.85 over three surveys depending on the pond). Population size classes based on numbers of captures were estimated as 'small' (*n*=3) or 'medium' (*n*=1) for both traps in four ponds, whereas in two ponds bottle traps yielded a 'small' and nylon traps yielded a 'medium' population. In two ponds the three sampling sessions resulted in recaptures for both trap types, allowing a comparison of population size estimates based on capture-mark-recapture. Estimates using nylon traps alone were similar to estimates using both trap types combined (Table 1). Nylon traps also performed better than bottle traps at recording non-target newt species present in the ponds (*T. marmoratus*, *T. marmoratus x cristatus* hybrids, *Lissotriton helveticus* and *L. vulgaris*) However, in line with high pond accessibility and low water turbidity, the associated torch surveys detected an overall larger number of *T. cristatus* than either of the two funnel traps (detailed data not shown).

Table 1. Captures of great crested newts (*Triturus cristatus*) using collapsible nylon traps and bottle traps (three sampling sessions each, for more details see the text). Figures denote absolute numbers of captures, followed by number of recaptures in brackets and resulting population size estimates using Begon's weighted mean (if applicable). Combined recaptures do not always represent the sum of both trap types because recaptures can occur across traps.

	Pond 1	Pond 2	Pond 3	Pond 4	Pond 5	Pond 6
Nylon trap	14 (2) 19.0±25.1	118 (13) 315.3±95.4	20 (5) 18.5±10.6	43 (0) n/a	2 (0) n/a	39 (5) 73.0±41.8
Bottle trap	2 (0) n/a	33 (4) 60.4±41.4	1 (0) n/a	13 (0) n/a	2 (0) n/a	9 (1) 12.0±36.0
Combined	16 (3) 20.8±18.3	151 (27) 288.0±57.7	21 (6) 18.0±9.0	56 (0) n/a	4 (0) n/a	48 (8) 85.6±35.0

The higher capture rate by the collapsible nylon trap is likely due to the presence of larger funnels at both ends (twice 22 x 22 cm, resulting in a 968 cm^2 capture area), whereas bottle traps create a single circular funnel covering 78.5 cm^2; this eleven-fold increase in capture area compares to a three-fold increase in *T. cristatus* captures. Bock et al. (2009) also suggested that it is more difficult for *T. cristatus* to escape from larger traps than from smaller traps. That surveys using nylon traps yielded significantly more captures than bottle traps suggests that they could drastically reduce survey effort needed to obtain reliable occupancy data (for British amphibians see Sewell et al., 2010). The higher population size estimates obtained though nylon traps further suggest that they can alleviate the general problem that surveys restricted to low sampling efforts regularly underestimate actual population sizes (MacKenzie & Royle, 2005). The 3 mm mesh of nylon traps however implies that they are rather unsuited for small newt larvae. It should also be noted that nylon traps cannot hold an air reservoir underwater, requiring controls at short intervals when deployed for example in deep water tethered to the bank of the pond.

In the UK, field surveys for amphibians have historically relied on the voluntary sector, and traps have thus been developed to be readily available and cheap. More recently, the majority of *T. cristatus* surveys are conducted by the commercial sector to meet legal requirements for site developers. Collapsible nylon traps require less space for storage and transport than bottle traps or larger trap types which are also reported to be highly efficient at capturing *T. cristatus* (e.g., Haacks & Drews, 2008; Drechsler et al., 2010). Another issue for consideration is the potential spread of chytridiomycosis; the collapsible nature of nylon traps means that a large number can be immersed into small volumes of liquid disinfectant. Given the larger size of nylon traps, the welfare of trapped newts should be comparable or better than for bottle traps; we did not observe any bycatch casualties such as water shrews in the present study, although such risks are difficult to assess for other study areas. While the utility of collapsible nylon traps still needs to be confirmed on a larger scale, our study suggests that bottle traps could be replaced by nylon traps during standard *T. cristatus* surveys.

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