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Estimations of the population size of Smooth Newts (*Lissotriton vulgaris*) breeding in a pond in Lincolnshire, England

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Abstract. The population size of smooth newts (*Lissotriton vulgaris*) in a small artificial pond was monitored during the spring and summer of 2007 using netting and bottle traps. Individual animals were identified from digital photographs of their ventral spot patterns. Although 20-25 newts were caught per trapping, four methods for estimating population size each gave values around 205 newts. The Schnabel method was considered to give the most precise population estimate. Trapping exhibited a clumped pattern because newts appeared to be leaving the pond only to return later in the season. Methods that count newts without identifying them run the risk of severely underestimating population sizes, which could impact on decisions about habitat protection and the survival of local populations.

Key words. Smooth newts, *Lissotriton vulgaris*, population estimate, clumped trapping pattern.

A pond at Riseholme Park campus of the University of Lincoln is home to smooth newts and as part of developing skills in practical conservation work a long-term study of the population size was established in the spring of 2007. Although originally intended as a means of introducing students to trapping techniques it became clear that the population size of the pond was more than was originally expected. Moreover, the recapture patterns of these newts appeared not to be random. This short report outlines the outcome of this study providing estimates of population size, using a variety of methods, and highlights the point that the observed number of newts in a pond may not reflect the population of animals using the habitat.

The study pond is set within a horticultural unit on Riseholme Park, Lincoln (53° 16' N, 0° 32' E). It is oval with a circumference of 15 m, a surface area of around 18 m^2 and has an approximate maximum depth of 1 m. Lined with PVC the pond has a well-established mixed marginal and aquatic flora. The immediate vicinity includes a tarmac road, mown grass, and flowerbeds. Within a radius of 100 m of the pond there are also several buildings, greenhouses and a stream. The nearest other pond to the study pond is around 200 m to the south-west and beyond the stream, and there is a large lake on campus – smooth newts are known to be present in the upper part of this lake at a location over 500 m away to the west and separated by a complex of buildings and roads.

Smooth newts (*Lissotriton* [*Triturus*] *vulgaris*) were caught on a regular basis (approximately 8-day intervals) from mid-March to mid-July 2007. Two methods were used: the first involved visiting the pond at dusk and searching the circumference of the pond with torches for adult newts, which were netted and transferred to a water-filled bucket where they were held overnight. The netting event was between 25-30 minutes and involved on average four people. The second method involved using ten bottle traps (2 L capacity; see Griffiths & Langton 2003) set in, and evenly around, the margins of the pond in the evening and left overnight. The traps were examined no later than 09.00 h the next morning and any adult newts caught were then examined. Bottle traps were used during the last four weeks of the trapping period as the numbers of newts caught began to decline and dusk occurred later. Juvenile newts lack ventral spots and so could not be individually identified. For this reason any juveniles caught were noted, but they were not included in the sample count.

To record ventral spot patterns a newt was lifted out of the water in the palm of the hand and allowed to crawl into a clear plastic 30 ml Universal tube and the top was loosely secured. This arrangement allowed the newt to be held securely but without excessive handling and contact with hands (minimising rapid increases in body temperature or dehydration). When held horizontally above the head the tube allowed digital photographs to be taken of the ventral surface of the newt. If at all possible the photograph would show the animal lying along the length of the tube and both the throat and belly spots would be visible. Preview of photographs ensured that a good view of the ventral surface was recorded before the sex of the newt was noted and it was released. All newts caught in any trapping event were released into the water at the same point in the pond although this varied between trapping events. It was considered that the small size of the pond did not prevent any newt from moving to any location within the habitat.

The photographs of the ventral skin patterns of black spots were examined to determine whether the individual animal had been previously captured or was a new individual. The pattern of spots was readily identifiable to individuals particularly if both the belly and throat patterns were compared. Identification of individuals was done by eye with reference to printed copies of photographs and all new animals were given a unique number. A record of each capture of the different individuals was made for each capture event.

Whilst the spot patterns of male newts were more obvious, visual recognition of female newts did not pose a problem. Identification was generally easier if pattern of spots were compared on both the belly and throat of the individuals. Intensity of black pigment

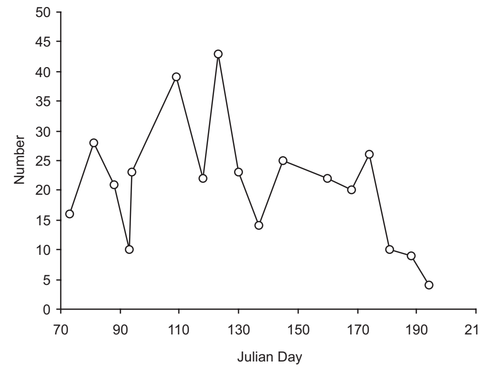

Fig. 1. Number of newts caught per trapping event, plotted as Julian day, in the spring and summer of 2007.

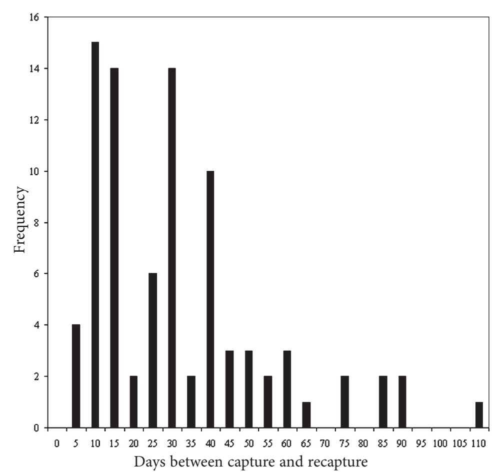

Fig. 2. Frequency distribution histogram of the days recorded for individual smooth newts between their initial capture and identification and their subsequent first recapture.

on the belly did vary through time, often fading as the season progressed, but intensity of spots on the throats of male newts showed little sign of fading.

Initial analysis determined whether the population was open or closed using the method outlined by Greenwood & Robinson (2006). The proportion marked in each sample showed a significant positive correlation with successive trapping occasions (Spearman's rank correlation coefficient, r_s = 0.900, $P < 0.001$) and so the population was considered to be effectively closed. There was no significant trend in the numbers caught per trapping event i.e. Julian day ($r_s = -0.363$, $P > 0.05$) although testing for the total numbers of marked newts caught per trapping did show a highly significant effect of time ($G = 82.1$, $P < 0.001$). This latter effect was probably due to the movement of newts to and from the pond over the course of the trapping period – there were fewer newts caught at the start and end of the trapping period (Fig. 1), which reflects changes in distribution of the newts between terrestrial and aquatic habitats (see Griffiths 1984). The two trapping techniques may have also contributed to this result because bottle-trapping may be less efficient than netting newts but this needs to be investigated.

Population size was estimated after each capture event using the two-sample method of Greenwood & Robinson (2006):

Population estimate = {([number caught + 1] x [total number caught previously + 1]) / [number of individuals recaptured+ 1]} – 1.

Three additional models (Greenwood & Robinson 2006) were tested for estimating the population size for newts using the pond. The pseudo-removal method allows for behavioural responses to being trapped, the Schnabel method allows for temporal differences between capture occasions, and the Burnham and Overton method allows for heterogeneity in catchability amongst individuals.

Over the four-month period (mid-March to mid-July) 172 individual newts were identified with more males (N = 110) being caught than females (N = 62). Eighty-six of the identified newts (50%) were recaptured at least once and the time between initial capture and the first capture varied 5 to 107 days with a median of 27 days (Fig. 2). More male newts were recaptured (61 versus 25 females), but they showed no significant difference in the time between capture and first recapture (medians = 27 days for both genders, Mann Whitney test, $P > 0.05$). Median number of captures per newt was 2 with thirty-eight

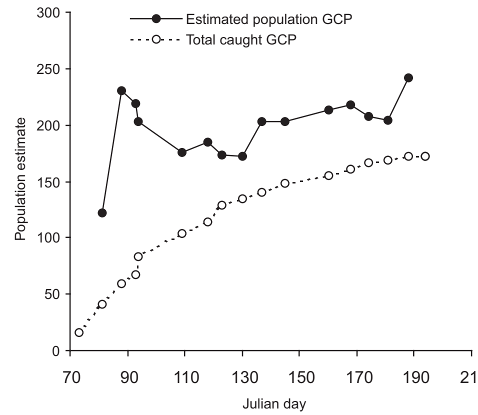

Fig. 3. Population estimate for the smooth newt population of GCP (Garden Centre Pond) using the two-sample method plotted against Julian day in 2007 together with the cumulative total for newts captured and identified.

newts caught twice, 26 caught three times, 14 newts were caught four times, 6 were caught five times, 3 were caught six times and 2 newts were caught seven times.

Except for the first and last values the population estimates (Fig. 3) derived from the two-sample method were comparable averaging 203 newts (SE = 6 and 95% confidence limits for the mean of ± 12 newts). Calculation of 95% CI for the population estimate for each trapping showed that these values were imprecise and another technique was required to estimate the newt population. However, the total number of newts caught over time did approach the estimated population of ~200 (Fig. 3).

Each of the three models yielded comparable population estimates although their levels of precision were different (Table 1). Given the lower confidence intervals it was judged that the Schnabel method provided the most precise method for estimating population size in this situation.

A dispersion index was calculated for each capture event following the method of Fowler et al. (1998) to test whether trapping of individuals was random. The number of newts for the first trapping was noted. For

Tab. 1. Estimates and 95% confidence intervals for population size for *Lissotriton vulgaris* utilising the Riseholme pond during the breeding season. Values are based on three different methods (Greenwood & Robinson 2006).

	Population estimate	95% confidence intervals
Pseudo-removal method	204	173 - 215
Schnabel method	202	190 - 215
Burnham & Overton method	210	168 - 252

the second trapping the number of newts caught previously was recorded together with the number of new newts. At the third trapping the number of newts trapped that were caught the first week were noted, as were those caught during the second trapping together with the new individuals. This method continued for each trapping event so that mean and variance values for the various trapping cohorts could be calculated. The dispersion index was calculated for each trapping event by dividing the mean by the variance and χ^2 was calculated by multiplying the value by the degrees of freedom (n–1). Therefore, for example, for trap event five a total of 23 newts were caught: none were recaptured from the first capture, 2 were recaptured from the second capture, 5 were recaptured from the third capture, none from the previous capture and 16 new newts were captured. Mean newt number per capture event was 4.6 and the variance was 44.6, $\chi^2 = 39.0$ for 4 degrees of freedom. Chi-squared values were then plotted against degrees of freedom to determine whether the values fell relative to the 95% confidence zone of random dispersal (Fowler et al. 1998). For two-thirds of the trapping events the numbers caught were not randomly distributed between the weeks of capture but showed clumped dispersal (Fig. 4). Only towards the end of the trapping season was the capture of newts more random according to previous trapping events.

The technique of identifying individuals from digital photographs of their spotting patterns worked well in this study. Although potentially time consuming for large samples, the method of holding the newt in a plastic tube was seen to be practically useful and also more welfare friendly than other systems of photographing belly spots (see Griffiths & Langton 2003). For male smooth newts in particular, patterns of throat spots proved more consistent over time than those of belly spots, which changed in intensity (but not pattern), probably according to breeding condition.

Seasonal change in newts captured in the pond were comparable to that shown by Griffiths (1984). This small study showed that the population of newts dependent on the pond was much higher than would be considered if individual trapping events were considered. Four different methods showed that the newt population of the pond was just over 200 newts. The consistency of estimates showed that this relatively small pond was of local significance to this population of smooth newts. However, casual observations would suggest that the newt population was rather limited; for any single trapping event only around 20 individuals were typically caught, but this is only 10% of the estimated population. Such a discrepancy could lead to a significant misinterpretation of the importance of the pond for smooth newts. In this instance, a professional ecological survey of this same pond in 2004 only observed 1-2 smooth newts. If this result is typical of similar ponds for this and other newt species then the implication for conservation of habitat is important. Simple counts of newts by torching, netting or trapping could suggest that the population dependent on the habitat is much lower than actually uses the pond over the course of a breeding season. Underestimation of a population could impact upon assessment of habitat quality and the need for its protection of various breeding sites (see Beebee & Grayson 2003).

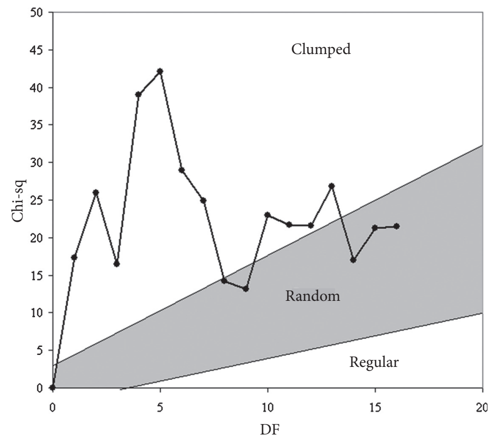

Fig. 4. Chi-squared values calculated from dispersion indices per trapping event (equal to DF +1) plotted against degrees of freedom (DF). Points lying in the area of the graph above the grey area exhibit clumped dispersion and points within the grey area exhibit random dispersion.

That the pond was a habitat for a closed population of newts means that its degradation or loss would severely impact on this population of animals. The nearest pond may provide an alternative habitat, but it is over a stream and, albeit quiet, road and is smaller than the original pond. Baker & Halliday (1999) showed that in an agricultural landscape, which matches that of Riseholme and its environs, the maximum distance between ponds travelled by smooth newts was 400 m. The upper part of the lake at Riseholme is at least 500 m distant and there would be a significant level of human infrastructure to negotiate for newts to move to this other habitat. Whilst smooth newts may not be a threatened species the loss of this pond would mean a significant loss of their habitat and the ecosystem that it supports.

The newts in this study were not trapped in a random or uniform manner and it seems that they are utilising the aquatic habitat as cohorts. One possibilty to explain this is that trapping or netting of newts was inefficient at recapturing newts at the start of the trapping season. However, the likelihood of capturing novel newts decreased as the season progressed even though trapping techniques remained constant. This suggests that the animals are leaving the pond for terrestrial habitats for extended periods of time over the breeding season (but are not apparently migrating away to other ponds), similar to smooth newts in German ponds (Weddeling et al. 2004), and so are not present to be caught within the aquatic habitat. In this study it was not possible to determine how far the newts travelled when they left the Riseholme pond and on-going investigations will ascertain the distances that the newts travel and where they seek refuge during the day.

In conclusion, this small study of a pond used by smooth newts in Lincolnshire suggests that the population is closed, but individual newts do not occupy the pond continuously over the breeding season. Individual trapping events would have severely underestimated the population size of newts using this small pond. Different methods for estimating population size varied in precision but were consistent in their population estimates. Care should be taken in estimating the size of newt populations and photographing ventral spot patterns allows for relatively easy identification of individuals that would provide realistic estimates of population sizes.

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