Effectiveness of translocation in mitigating reptile-development conflict in the UK

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SUMMARY

The translocation of reptiles from development sites is a frequent but controversial intervention to resolve reptile-development conflicts. A general lack of post-translocation monitoring means that the fate of translocated reptiles is largely unknown. Here we report on the outcome of six reptile translocations carried out to mitigate the impacts of development. Through detailed post-translocation monitoring, we sought to determine whether translocated reptiles established populations within the receptor sites.

To determine the effect of translocation, we investigated six sites within the UK that had received populations of translocated slow-worm *Anguis fragilis*, viviparous lizard *Zootoca vivipara*, adder *Vipera berus* and / or grass snake *Natrix helvetica*. Identification photographs were taken of all reptiles during the translocation. Following release, between one and three years of post-translocation monitoring was undertaken; during the monitoring, identification photographs were again collected to establish whether captured individuals were part of the translocated populations.

Very few translocated individuals were encountered during the post-translocation monitoring. The mean number of translocated reptiles was 98 (SE 19.61). Of these, an average of 1.5 (SE 0.72) individuals or 1.6% of the population were captured during the monitoring. No recaptures of translocated reptiles were made at three (50%) of the study sites. The low recapture rates of translocated reptiles could be due to mortality, imperfect detection (including inaccurate identification of individuals) or post-translocation dispersal. There is some limited evidence to support each of the possible options, but post-translocation dispersal is considered to be the most likely explanation.

The study found no confirmatory evidence that mitigation-driven translocations are compensating for the losses of populations to development.

BACKGROUND

Reptile introductions and translocations are implemented in many countries in an attempt to combat global declines. Whereas conservation translocations are primarily focused on reintroductions and the reinforcement of declining populations, mitigation translocations seek to avoid further losses by moving reptile populations from the footprint of imminent development (for example new roads, housing estates or aggregate extraction). In each case, the purposes of translocation are the establishment of a viable and self-sustaining population (Griffith *et al*. 1989).

Dodd and Seigel (1991) reported that reptile translocations had very low success rates and that, in general, herpetofauna were unsuitable candidates for translocation. This conclusion was reported by other studies including that of Butler *et al*. (2005), who reported that just 19% of reptile translocations were successful and, of these, none involved snakes. Germano and Bishop (2008) undertook a meta-review of 91 herpetological translocations and again reported low success rates for reptiles. This latter study went further in identifying that the motivation for translocation (i.e. conservation or development-led) was an important determinant of success; the highest failure levels (63%) were associated with development-led translocations of reptiles.

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In one of very few studies that included detailed post-translocation monitoring, Platenberg & Griffiths (1999) describe the continued persistence of slow-worms two years after the translocation. The authors reported that the slow-worms had lower body condition than nearby natural populations and showed no evidence of breeding within the monitoring period. As the population persisted in the short-term, standard monitoring (based on count data only) would indicate success; however, more detailed quantitative data led the authors to question the conservation value of such translocations.

Most of the cited studies were in North America, Australia and Asia; there are few studies involving the translocation of reptiles available for the UK. The 'Conservation Evidence' website does not reveal any studies involving the translocation of reptiles. The paucity of detailed monitoring data means that the fate of translocated individuals is largely unknown. Without this knowledge, it is impossible to determine whether current approaches to mitigation benefit reptile populations. This is a fundamental shortcoming in our knowledge of translocations and is likely to be a contributory factor in the high levels of failure reported for development-led reptile translocations (Germano & Bishop 2008).

Through detailed post-translocation monitoring, we sought to establish what proportion of translocated reptiles remained within the receptor site as part of an established population.

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ACTION

Site Selection

All sites used in this study were supplied by third party ecological consultants. Suitable sites were selected based on the following criteria:

- The impacted site should support a population or community of 'widespread' reptile species (slow-worm, viviparous lizard, adder or grass snake);
- The impacted site would be subject to development, either partially or fully, within the anticipated timescales of this study; and
- Access to the receptor site would be granted for the primary author to undertake follow-up surveys of the translocated reptiles.

Of the six sites, two were located in South Wales, three in Essex and one in Oxfordshire (Figure 1). The sites varied in size, habitat and species composition and the nature of the ensuing development; however, all are real world examples of development-led translocation in the UK and are typical of current practices.

Figure 1: The distribution of the six study sites (represented by stars) was spread across Southern England and Southern Wales. This spread was dictated by the availability of study sites and willingness of consultants and developers to participate in the project.

Site 1: South Wales

The receptor site included approximately 10 ha of amenity land (sports pitches), semi-improved and marshy grassland along with secondary broadleaved woodland connected by a series of tarmac walkways. Two areas were augmented with purpose-built hibernacula constructed from earth and inert rubble. The park was used by local residents for recreational purposes principally including dog walking and ball sports. The receptor area was not enclosed by physical barriers other than to the north, where residential housing bounded the site.

Site 2: Oxfordshire

The receptor site was situated on a golf course and specifically within an area of rough grassland. Beyond the release site, the habitats included a mosaic of amenity (mowed short) and rough grassland, scrub, trees and open water; the total area of the golf course was greater than 100 ha. The release site was partially connected to the wider landscape by contiguous suitable habitats interspersed by short (c. 30 m) strips of amenity grassland. There were no physical barriers to movement.

Site 3: Essex

The release area comprised a 21 ha restored grassland / wetland that was jointly managed as a surface water catchment area and a reserve for a range of taxa. The receptor site consisted of a series of large densely vegetated earth mounds set within a mosaic of rank grassland and scrub. These habitats extended beyond the receptor site to the north, east and south and there were no physical barriers to movement.

Site 4: Essex

The receptor site had been fenced off to prevent public access and included a 1 ha mosaic of rough grassland, scattered scrub and secondary birch woodland. Three piles of cut vegetation had been created and were being used as a point of release for the reptiles. The wider release area consisted of pasture, rough grassland and walkways. The boundary fence would not prevent reptiles from migrating into or out of the receptor site.

Site 5: South Wales

The 1.3 ha receptor site was constructed on an area of previously worked and restored habitat within a quarry, situated approximately 1 km to the south-west of the development site. A range of habitat types were present within the receptor site including sparse grassland, marsh and scattered scrub. To prevent translocated reptiles from moving near to watercourse reinstatement works, a reptile exclusion fence was erected along the eastern and northern boundaries. No fence was located to the west or south, rather a densely wooded valley demarked the extent of the receptor site. Beyond the wooded valley was further suitable habitat comprising rough grassland and scattered scrub.

Site 6: Essex

Both the donor and receptor sites were located within the same disused golf course in Essex, however they were separated by over 500 m of mixed habitats. The receptor site comprised a mosaic of rough grassland, scrub and secondary woodland, largely enclosed by amenity grassland. Three hibernacula were created in the receptor site by the consultants using cut vegetation. The wider release area included habitats typical of a golf course. There were no physical barriers preventing the dispersal of animals into the wider area.

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Table 1. A summary of the study sites showing the size and species composition of translocated populations. N – total number translocated; N* - number of each species translocated; Zv – viviparous lizard, Af – slow-worm, Nh – grass snake, Vb – adder.

Site	N	N*				Year of	Monitoring	
		Zv	*Af*	*Nh*	*Vb*	Translocation	Year(s)	No. Visits
Site 1	172	172	0	0	0	2012	2013, 2014	8
Site 2	102	102	0	0	0	2013	2015	4
Site 3	114	114	0	0	0	2012	2013 - 2015	12
Site 4	45	15	28	2	0	2012	2013 - 2015	14
Site 5	111	84	27	0	0	2012	2013 - 2015	31
Site 6	45	0	0	0	45	2013	2015	6

Translocation

During the translocation, the consultants engaged to carry out the work were asked to take identification photographs of all individuals. All four widespread species reptiles found in the UK are readily recognisable from natural markings and scale patterns (Carlström & Edelstam 1946; Sheldon & Bradley, 1989).

Monitoring

Following the release of the reptiles, a programme of post-translocation monitoring was undertaken at each receptor site (Table 1). Where possible, the annual monitoring period was timed to match that of the translocation period. The number of years of monitoring and the number of visits were dependent on the year of the translocation relative to the study. A minimum of four visits per annum were undertaken at each site, which was considered sufficient to detect a species (if present) with a confidence level of 95% (Sewell *et al*. 2012).

To maximise the likelihood of detecting reptiles, the survey included two distinct techniques during each visit; namely Visual Encounter Survey and Artificial Cover Object Survey (see McDiarmid et al. 2012). When used in combination these two techniques greatly increase the detectability of native British reptiles (Sewell *et al*. 2013).

Data Analysis

By comparing pre- and post-translocation identification photographs (Figure 2), we determined the number of reptiles, and ultimately the proportion of the translocated population, that remained within the receptor site.

A Kruskal-Wallis test was used to assess whether the proportion of recaptures differed between species. This analysis was restricted to slow-worm and viviparous lizard, both of which were recorded from multiple sites. Relationships between the pooled number of animals moved (N) and the number recaptured (R) and the pooled number of animals recaptured (R) and the size of the release site were tested for using multiple linear regression.

CONSEQUENCES

Very few translocated individuals were detected after their release (Table 2). This trend of low recaptures was consistent across all study sites with little variation. The mean number of reptiles translocated per site was 98 (SE 19.61), and on average 1.5 (SE 0.72) or 1.6% were recaptured during the monitoring. No recaptures of any translocated reptiles were made at three out of the six study sites, which were subject to between four and 12 survey visits over the course of the monitoring.

Table 2: A summary of recapture data by site. N – number translocated; R - total number of individuals recaptured*; R / Year – number recaptured each year. Af – slow-worm, Zv – viviparous lizard, Nh – grass snake, Vb – adder.

Site	Species	N	R (%)	R / Year		
				Year 1	*Year 2*	*Year 3*
1	*Zv*	172	0	0	0	0
2	*Zv*	102	0	0*	-	-
3	*Zv*	114	0	0	0	0
4	*Zv, Af, Nh*	45	4 (8.9)*	3 (*Af*)	3 (*Af*)**	-
5	*Zv, Af*	111	3 (2.7)*	3 (2 *Af*, 1 *Zv*)	0	2 (*Af*)
6	*Vb*	45	2 (4.4)	2 (*Vb*)	-	-

* This excludes subsequent recaptures of the same individual; ** two individuals - one individual was captured on two occasions

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The observed recapture rates were influenced by species composition. The most frequently translocated species was the viviparous lizard, which occurred at five out of six sites. Each translocation of the species averaged 97.4 (range 15 - 172) individuals, of which on average 0.2 (SE 0.2) were recaptured. The second most frequently translocated species was the slow-worm, which occurred at two sites. Slow-worm translocations averaged 27.5 individuals (SE 0.5) with mean recapture rates of 3.5 (SE 1.5) individuals. A Kruskal-Wallis test detected a significant difference between the proportion of slow-worms (range 2 – 4) and viviparous lizards (range 0 - 1) that were recaptured ($H_{(1)} = 4.565$, $p = 0.03$). Slow-worms were more than twice as likely to be recaptured than viviparous lizards. Insufficient translocations of grass snake and adder were undertaken to enable a comparison for these species. No significant relationships were detected between the number of animals translocated (N) the number subsequently recaptured during the monitoring (R) and the size of the receptor site (all $p > 0.05$).

Using photographic identification, non-translocated individuals were detected at sites 4 (24 slow-worms, three viviparous lizards and one grass snake) and 5 (30 slow-worms and 31 viviparous lizards) where, according to the respective consultants, no reptiles were observed pre-translocation. At site 6 adders were translocated into a known resident population, and although only two out 45 translocated adders were recaptured, 16 resident adders were observed.

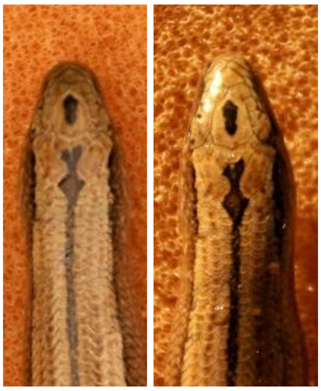

Figure 2: An adult female slow-worm captured during translocation (A) and again during post-translocation monitoring (B). Unique patterns found on the cranial scales allow individuals to be re-identified without the need to apply a physical mark.

DISCUSSION

The translocations differed in terms of the species and numbers of animals involved, the habitat structure of both donor and receptor sites and geographic location. Despite this variation, all were typical examples of mitigation practices in the UK, rather than controlled before-after experiments. However, more controlled experiments would not have reflected current practice. All cases involved consultants relocating reptiles to a release area to facilitate development at the removal site. Overall, some 589 reptiles were translocated to the six receptor sites, of which nine animals (1.5%) were subsequently recaptured during three years of post-releasing monitoring. Indeed, no recaptures were made at all at three of the six sites and capture-mark-recapture modelling was therefore not possible.

Four possible explanations for the observed recapture rates are: 1) the translocated reptiles perished following release (including overwintering mortality); 2) the monitoring failed to detect the translocated individuals; 3) animals were captured but could not be reliably identified; or 4) the reptiles migrated away from the release site (post-translocation dispersal). Although all four of these options could actively influence translocations, post-release dispersal is considered to be the most likely cause. Post-release dispersal has been shown to greatly influence the outcome of translocations (Tuberville *et al*. 2005; Stamps & Swaisgood 2007; Germano & Bishop 2008; Knox & Monks 2014). The very few recaptures reported could be explained by the migration of reptiles away from the release area. Sites 3, 4 and 5 were immediately bordered by suitable habitat and lacked physical barriers to movement. Sites 2 and 6 were situated adjacent to but not directly connected with suitable habitat. Nash and Griffiths (2018) observed that three male adders fitted with a radio transmitter all migrated away from the release site, with two returning to the donor site. By contrast, all four translocated females remained within the release area. In 1995, 104 slow-worms were translocated from a development site in Canterbury to a 1.7 ha island (Platenberg & Griffiths 1999). Although the population declined, high recapture rates (60%) were recorded for several years following the release. In this instance, the presence of physical barriers appeared to have increased site fidelity, which accords with studies of artificially penning translocated reptiles (Knox & Monks 2014).

Post-release dispersal reduces the number of individuals available for detection within a population. Although the consequences of emigration are varied, they are often negative. Migrating reptiles might occupy unsuitable adjacent habitats (sites 1 and 2) or sites designated for future development. However, migrating individuals might also settle in suitable adjacent habitats (site 3 for instance). In either case, individuals that migrate away from the release site will not contribute either demographically or genetically to the population (Le Gouar *et al*. 2012).

Dispersing individuals face high risks of predation (Bonnet *et al*. 1999). Post-translocation dispersal ultimately results in smaller populations, which are more likely to become extinct. Two of the study translocations involved relatively small numbers of reptiles (45 individuals); if most of these disperse from the release site then the chances of establishing a population are reduced. Even relatively small emigrations could result in insufficient individuals to maintain a viable long-term population.

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Post-translocation monitoring identified populations of resident reptiles at four of the six study sites including two where no reptiles were observed prior to the translocation. It is possible these could be translocated individuals that were mis-identified, or individuals that colonized the sites between the pre- and post-translocation surveys. However, assuming that these were not misidentifications, standard post-translocation monitoring, comprising simple presence counts, would not have identified these animals as natural colonizers. Indeed, the presence of these residents would have been (and presumably are being) misinterpreted as evidence of a successful translocation. This highlights the need to collect individual-based monitoring data both before and after mitigation. Simple presence-absence counts alone, as recommended by published guidance (Froglife, 1999), are not sufficient to ascertain whether a translocated population has become established. To identify the outcome of a translocation, it is essential to be able to re-identify individuals post-release. However, until published survey guidance includes a need for more detailed data, it is unlikely that it will be collected.

Although mitigation translocations may prevent the immediate death of animals that would otherwise be extirpated by the destruction of their habitat, there is little evidence that they are compensating for the loss by founding populations elsewhere.

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