Available online at www.sciencedirect.com
SCIENCE DIRECT®
Biological Conservation 122 (2005) 45–52
BIOLOGICAL CONSERVATION
www.elsevier.com/locate/biocon

Evaluation of translocation as a tool for mitigating development threats to great crested newts (*Triturus cristatus*) in England, 1990–2001

Paul W. Edgar [a,1], Richard A. Griffiths [a,*], Jim P. Foster [b]

[a] *The Durrell Institute of Conservation and Ecology, University of Kent, Canterbury, Kent CT2 7NS, UK*
[b] *English Nature, Northminster House, Peterborough PE1 1UA, UK*

Received 2 March 2004; received in revised form 7 May 2004; accepted 14 May 2004

Abstract

Great crested newts (*Triturus cristatus*) are protected under European and UK legislation, but are frequently the subject of conflict between development and conservation in England. When this occurs, the developer is legally obliged to instigate a mitigation plan to reduce the impacts on the newts. This usually involves the translocation of newts coupled with habitat enhancement and creation. We reviewed mitigation projects carried out in England between 1990 and 2001 by (1) analysing licensing information collected by the governmental licensing authorities; and (2) a questionnaire survey of a sample of mitigation projects. Over half of the licensed projects on file contained no report of the work undertaken. There was an increase in the number of new translocation projects from less than 10 a year in the early 1990s to over 80 a year by 2000. This translates into about £1.5 million per year currently being spent on great crested newt mitigation projects. Most of these projects involved in situ translocations of newts to areas within or adjacent to the development site. The number of newts translocated per project declined over the same period, and was related to the total area of habitat destroyed and work effort. About 27% of great crested newt terrestrial habitat was destroyed during the developments along with about half of all ponds. Although the number of new ponds created compensated for the number of known great crested newt ponds lost, there was a net loss in terms of overall area of aquatic habitat. Where follow-up monitoring of translocations was conducted, there was evidence of breeding at most sites one-year post-development, but it is unclear whether these populations were sustainable in the long-term.

Keywords: Animal relocation; Amphibian; Mitigation; Legislation

1. Introduction

Animal translocations are usually carried out for one of three reasons – (1) to solve human–animal conflicts; (2) to supplement game populations; and (3) for conservation purposes (Fischer and Lindenmayer, 2000). Conservation translocations are those exercises that have the specific aim of establishing new populations of animals or plants with a view to enhancing their local, regional or national status. Most often, such translocations take the form of reintroductions of species into areas within the historical range from which they have become extinct. Since poorly designed or executed translocations can actually pose a risk to biodiversity (e.g. Conant, 1988; Cunningham 1996; Hodder and Bullock, 1997), there are now standard protocols for undertaking such

---

[*] Corresponding author. Tel.: +44-1227-823434; fax: +44-1227-827839.
E-mail address: r.a.griffiths@kent.ac.uk (R.A. Griffiths).
[1] Present address: The Herpetological Conservation Trust, 655a Christchurch Road, Boscombe, Bournemouth, Dorset BH1 4AP, UK.

0006-3207/$ - see front matter © 2004 Elsevier Ltd. All rights reserved.
doi:10.1016/j.biocon.2004.05.022

work (e.g. IUCN, 1995; JNCC, 2003). A further type of translocation involves removing individual animals or plants from sites that are scheduled for development. In terms of execution, such 'rescue' translocations have much in common with those carried out to resolve human–animal conflicts (e.g. Craven et al., 1998). Generic protocols for such activities are much less well developed, as they are reactive actions driven by development pressures rather than by proactive conservation priorities. Moreover, the legislative framework that regulates such actions often places more emphasis on the protection of individual organisms than wider biodiversity issues (Harrop, 1999).

In their literature review of animal translocations, the number involving amphibians, reptiles or invertebrates comprised just 7% ($n = 12$) of the total number of case studies (Fischer and Lindenmayer, 2000). Indeed, as far as amphibians are concerned, there have been arguments both for (Bloxam and Tonge, 1995; Marsh and Trenham, 2001) and against (Seigel and Dodd, 2002) using these animals in translocation and reintroduction programmes. However, one species that is increasingly subject to translocations in England is the great crested newt (*Triturus cristatus*). Although this species is widely distributed across north-west Europe (Griffiths, 1996), it is declining in many countries within its natural range and in Britain is strictly protected under the Wildlife and Countryside Act 1981 and the Conservation (Natural Habitats &c) Regulations 1994. As the species is widespread in England it frequently occurs on land threatened by development, and so is often the subject of conflicts between development and conservation. In order to meet legal requirements, if development proceeds a mitigation plan is normally implemented to reduce damaging impacts on the newts. Typically, such mitigation involves the capture and exclusion of newts, and their relocation to areas that have been subject to habitat creation, enhancement or restoration. The relocation areas may be either in situ (i.e. within or adjacent to the area of development), or ex situ (i.e. an area not linked to the development site). Such work can only be done under licence from the appropriate government authority.

As information about individual mitigation case studies is usually confined to licence returns and reports by ecological consultants to their clients, there are only a few published case studies of these activities (e.g. Gent and Bray, 1994; Cooke, 1997, 2001; Green, 2000; Oldham and Humphries, 2000). Oldham et al. (1991) collated information from 64 great crested newt translocations carried out between 1970 and 1990. Their study revealed that great crested newts had been released into existing populations as well as new sites over this period, and they concluded that their data did not provide conclusive evidence of the success or failure of translocation. A further (unpublished) study by May (1996) collated data on great crested newt translocations between 1990 and 1994. As Oldham et al. (1991) also observed, the procedures used and the degree of monitoring varied considerably between projects, although there was evidence of breeding in some 61% of sites that were monitored post-translocation. Oldham and Humphries (2000) collated data from the two earlier reviews, resulting in a pooled data set of 178 translocations. They concluded that 37% were 'successful' (at least on the liberal criterion of the presence of a population one year after the translocation), and 10% were 'unsuccessful'. However, 31% of projects were not monitored at all and there were no data available for a further 12% of projects (Oldham and Humphries, 2000).

These earlier reviews considered translocations in the broad sense, and many projects examined were simple relocation of animals from one site to another (e.g. introductions to garden ponds) with no other measures such as habitat creation. The current study specifically examined projects instigated in response to development threats. In addition to gathering data on the fate of newt populations, it is also important to know whether translocation activities have been accompanied by any gains or losses of newt habitat, as well as the effort and costs involved. The current project addressed these issues using two approaches: (1) by collating information held by the British Government licensing authorities; and (2) by using a questionnaire to obtain more detailed information on a large sample of mitigation projects carried out between 1990 and 2001.

2. Materials and methods

2.1. Sampling of the great crested newt licence database

Information about great crested newt mitigation projects was obtained from the following sources: (1) English Nature licensing files for the period 1990–2000, which contained hard copies of licence applications and mitigation project proposals, licences issued, licence returns and subsequent reports; (2) a database of English Nature licences issued from 1997 to 1999 (including some from up to March 2000); (3) files and hard copies of data obtained during a previous assessment of great crested newt mitigation by May (1996); and (4) the Department of the Environment, Food and Rural Affairs licensing files for the period 2000–2001 (Defra; the Government department that issued mitigation licences from March 2000), which contained annual licence tracking sheets, copies of licences issued, licence returns and mitigation reports. The complete data set therefore embraced the period from 1990 to 2001. For the purposes of this study we adopted the definition of translocation used by the Joint Nature Conservation Committee (JNCC, 2003) – 'the transfer by human agency of any organism(s) from one place to another'. Licensing and other information was first checked to confirm that great crested newts had in fact been translocated for a development mitigation project, rather than as part of some temporary disturbance, such as conservation management work, or for a simple introduction attempt to a garden pond. In addition, licences were cross-referenced to determine whether those issued in subsequent years – or to different ecological consultants – had been for the same mitigation project. The following information was then collated from the various sources of information: (1) mitigation project name, location, development dates and details of all licences issued; (2) the type of development requiring mitigation; (3) the type of mitigation carried out, i.e. whether an in situ or ex situ translocation of newts was performed; (4) the numbers and stages of newts actually translocated; (5) details of any post-mitigation monitoring.

2.2. Questionnaire sampling of great crested newt mitigation projects

As the information contained with the licence returns varied in detail, a number of mitigation projects were selected for more detailed analysis by questionnaire analysis. Because of the variability in the quality of information already on file, the uneven distribution of mitigation projects over time, and the fact that over half of all mitigation studies had been conducted by only 22 consultants, random sampling was considered to be inappropriate. Instead, projects were selected on the basis of the quality of data already available while aiming for as even a spread as possible across the timeframe sampled. An additional constraint was not to send more than five questionnaires to any one consultant. This resulted in a total of 153 projects being selected for the questionnaire survey. The questionnaire sought more detailed information on the type of development; pre-development assessment of the newt populations and the aquatic and terrestrial habitat affected; details of methods used to capture newts and the number of newts translocated; details of the receptor site and any habitat enhancement, management or creation; post-development monitoring; problems encountered before, during and after the mitigation. In situ receptor sites were defined as those sites managed for great crested newts that are less than 500 m from the original development site and not separated by any major newt dispersal barriers; ex situ receptor sites were defined as those sites that received newts that were greater than 500 m from the original development site or separated from the original site by a major dispersal barrier (e.g. major road).

The final version of the questionnaire was drafted following feedback from a pilot survey of 10 experienced ecological consultants and other conservation organisations involved with mitigation.

3. Results

3.1. Great crested newt licence database

A total of 737 great crested newt licence files were examined. English Nature issued 427 of these licences during the period 1990–2000, with the remaining 310 subsequently being issued by Defra (or its immediate predecessor, DETR) in 2000 and 2001. A total of 649 of these licences, issued to 164 individuals and ecological consultancies, collectively cover 345 great crested newt mitigation projects started between 1990 and 2001. Another 50 licences were issued for projects, such as pond maintenance, by conservation bodies that are not considered to be mitigation work as defined by this study. In addition, licences were sometimes cancelled almost immediately due to necessary project amendments, some remained unused altogether due to various work delays and cancellations, while others were variously revoked or otherwise not required – these account for a further 38 licences.

Although providing a report on the work carried out is a condition of licence issue, there were no reports on file for over half of the licences issued between 1990 and 2001. Even excluding mitigation studies started after 1999 that may not yet be completed, the return rate appeared to be just 45%. Consequently, it is not known how many newts were translocated, if mitigation proceeded as proposed in the licence application, or even if the project had taken place at all for the majority of licences issued.

There has been a clear increase in the number of great crested newt mitigation projects started each year from less than 20 in the early 1990s to over 80 a year towards the end of 2000 (Table 1). The number of licences issued exceeds the number of projects, as many projects lasted more than one year and required ongoing licences. Although over 70% of projects involved in situ rather than ex situ translocation over the entire study period, comparing the periods 1990–1995 and 1996–2001, revealed a significant shift away from ex situ translocation to in situ translocation over time (χ^2=6.8, df=1, $P < 0.01$).

3.2. Questionnaire returns

Of the 153 questionnaires circulated to 114 individuals, 84 were returned by 62 individuals, representing a response rate of 55%. However, three questionnaires were returned with zero information, and a further nine questionnaires contained such little information that they were also discounted. The final number of projects analysed from the questionnaire survey therefore represented 72 mitigation projects. As these comprised some 17 projects carried out from 1990 to 1997 and 55 projects carried out from 1998 to 2001, more data were

Table 1
Licences issued for great crested newt mitigation projects (1990–2001)

Year	Total no. projects started	Total no. licences issued[a]	Mean no. licences/project	SD	Range	Mean no. consultants per project	SD	Range
1990	3	3	1.0	0.00	1–1	1.0	0.00	1–1
1991	6	17	2.8	4.02	1–11	1.8	0.41	1–2
1992	6	12	2.0	1.55	1–5	1.8	0.41	1–2
1993	12	23	1.9	1.93	1–6	1.1	0.29	1–2
1994	21	36	1.7	1.55	1–6	1.1	0.44	1–3
1995	6	18	3.0	2.61	1–8	1.7	0.82	1–3
1996	11	33	3.0	2.53	1–8	1.6	1.03	1–4
1997	33	71	2.2	2.20	1–11	1.2	0.53	1–3
1998	37	102	2.8	2.57	1–14	1.4	0.63	1–3
1999	39	79	2.0	1.71	1–8	1.6	0.54	1–4
2000	87	158	1.8	1.24	1–9	1.1	0.29	1–2
2001	84	97	1.2	0.45	1–3	1.0	0.00	1–1
Total	345	649	1.9	1.74	1–14	1.1	0.45	1–4

[a] Indicates licences issued throughout the duration of each project – excludes 63 licences not found in English Nature files.

available for projects carried out in later than earlier years.

3.3. Mitigation work effort

The mean duration of mitigation projects – as defined by the time between first and last licensing – was 1.8 ± 1.16 years (mean ± SD). Projects started in 2000 or 2001 were excluded from this analysis, but a comparison of the periods 1990–1994 and 1995–1999 revealed no significant differences in the duration of mitigation projects (Mann–Whitney U test: $U = 3526$, $n_1 = 48$, $n_2 = 126$, $z = 1.69$, $P > 0.05$). In terms of overall time spent on mitigation activities (including general administration, planning, execution and reporting), 59% of projects spent up to 80 days on mitigation work, and a further 26% of projects up to 240 days. Assuming project management fees are about £300 per day and other elements of mitigation work are charged at £150 per day by consultants (based on quotes from consultants seen by English Nature officers), the cost of a mitigation project can vary from about £1350 for a project lasting just a few days to well over £100,000 for projects involving hundreds of days of work over several years. The average cost of a mitigation project would be in the region of £15,000–£20,000, not including plant hire and equipment costs. Based on the number of projects currently being licensed (Table 1), this translates into about £1.5 million per year being spent on great crested newt mitigation projects in England.

Over half of all mitigation work was focused on building developments, including both residential and commercial developments. The remainder were roughly evenly distributed between developments associated with mineral extraction, transport and pipelines. All other types of development, including those associated with sports and recreation development, collectively accounted for less than 20% of projects.

3.4. Numbers of newts translocated

Questionnaire responses based on 72 projects showed that prior to translocation, the status of newts was determined at all sites by the use of pre-existing records and/or a specially commissioned survey. Although a variety of methods was used in the surveys, the vast majority of surveys just established presence or absence, or used a simple counting method. Only one project out of 72 attempted a detailed population estimate of the number of newts actually present.

Information about the numbers of newts translocated was available for 139 projects in the licence database, and this includes all those in the questionnaire sample. As the licence database did not always contain clear information about the stage of newts translocated, the data shown represent post-metamorphic newts only (i.e. fully transformed aquatic or terrestrial juveniles, immatures or adults). Although the number of newts translocated per project was highly variable, there was a general trend for the numbers relocated to decline over time (Table 2). Indeed, the mean number of newts relocated per project between 1990 and 1994 declined from an average of about 358 to one of 172 newts from 1995 to 2001, and this difference was significant ($t = 2.6$, df=137, $P < 0.01$). As there is no legal requirement to determine the actual population size prior to development it is not known what proportions of the populations were actually translocated.

The numbers of newts translocated per project were positively related to (1) total areas of great crested newt habitat destroyed ($r_s = 0.59$, $n = 41$, $P < 0.001$); number of capture methods used ($r_s = 0.54$, $n = 64$, $P < 0.001$); number of days spent capturing newts ($r_s = 0.47$, $n = 56$, $P < 0.001$) and number of days spent on the entire mitigation project ($r_s = 0.54$, $n = 25$, $P < 0.01$).

Table 2
Summary of numbers of post-metamorphic great crested newts translocated

Year	Total no. mitigation projects	No. mitigation projects			No. newts moved	Range	Mean no. per project	SD
		No data available	Exclusion only	Data available				
1990	3	1	0	2	889	9–880	444.5	615.89
1991	6	2	0	4	1331	1–879	332.8	383.70
1992	6	1	0	5	3561	33–2234	712.2	870.88
1993	12	2	0	10	3124	1–1571	312.4	540.36
1994	21	7	0	14	3637	1–1405	259.8	427.09
1995	6	3	0	3	155	4–86	51.7	42.60
1996	11	4	0	7	408	0–308	58.3	114.01
1997	33	15	1	17	603	0–148	35.5	50.64
1998	37	17	0	20	2364	0–917	118.2	208.76
1999	39	14	2	23	4267	0–2140	185.5	501.32
2000	87	62	4	21	3325	0–1576	158.3	378.23
2001	84	70	1	13	230	0–100	17.7	32.62
Total	345	198	8	139	23,894	0–2234	171.9	390.56

'Exclusion only' refers to projects where newts were prevented from wandering on to the development site by fencing, rather than being physically relocated.

3.5. *Effects on aquatic and terrestrial habitat*

Based on the questionnaire responses, the area of great crested newt habitat destroyed during the development averaged 27%. In the case of linear developments, such as pipeline installation, the area of a habitat lost was lower at 9% of the total area.

As development sites contained ponds where the presence of great crested newts had not been confirmed – as well as other ponds where great crested newts were known to be present – data on the fate of ponds were analysed separately in these two categories. When all ponds on development sites are considered, about half were destroyed during the course of development (Table 3). In fact, the proportion lost to development is exactly the same when only confirmed great crested newt ponds are considered. Consequently, under half of the original ponds on the sites were retained or improved during the mitigation projects. In terms of the areas of water lost per site, developments resulted in a 72% loss of aquatic habitat when 'all ponds' are considered, and a 30% loss of aquatic habitat when just 'confirmed great crested newt ponds' are considered. In terms of the new ponds that were created as part of the mitigation, neither the number of new ponds, nor the overall surface area of

Table 3
Comparison of aquatic habitat lost and gained during great crested newt mitigation projects

	All ponds on development sites	All ponds destroyed by development	No. confirmed crested newt breeding ponds only[a]	Crested newt ponds destroyed by development	New ponds created[b]
Number of ponds					
Total number	243	123	115	59	74
Mean no./site	3.7	1.9	1.9	1.0	1.2
SD	5.88	5.30	3.39	3.29	1.64
Range	0–31	0–31	0–25	0–25	0–7
No. of sites	65	65	60	60	60
Surface area of ponds[c]					
Mean area (m^2)	809.4	738.4	804.4	340.0	196.8
SD	2349.90	1792.20	1829.10	527.22	416.35
Range (m^2)	1–20,800	1–11,200	2–11,500	2–2400	4–3000
No. of ponds	154	56	74	23	65
Mean area/site[d]	2955.6	2130.0	1656.3	494.4	381.3
SD	9289.70	4612.90	2992.20	891.80	621.81
Range (m^2)	3–59,225	3–20,545	3–13,580	3–2781	4–3000
No. of sites	42	24	35	16	32

[a] This does not imply that the remaining 128 original ponds on the development sites were not used as questionnaire returns indicate that great crested newts may have been breeding in at least a further 57 of these ponds (unconfirmed information excluded from table).

[b] Includes two ponds created on two separate ex situ receptor sites, as well as 72 created on 34 in situ sites.

[c] The numbers of ponds with surface area information provided is less than the total numbers of ponds.

[d] Mean pond area/site only includes those sites for which this information was provided.

Table 4
Results of monitoring results carried out for up to five years post-development

	Year 1	Year 2	Year 3	Year 4	Year 5
No. receptor sites surveyed per year	32	13	7	5	3
No. receptor sites with adult crested newts	28	12	6	5	3
No. receptor sites with crested newt eggs	18	7	6	4	3
Mean no. adult crested newts recorded per year	61.7	18.3	14.3	25.4	34.0
SD (newts recorded)	158.46	22.04	13.65	26.97	40.37
Range (newts recorded)	0–848	0–74	0–31	3–70	1–79

water created, compensated for the corresponding values for 'all ponds' lost (Table 3). Although the number of new ponds created did exceed the number of confirmed great crested newt ponds lost, there was still a net loss of aquatic habitat when water surface area in these two categories is compared.

As most mitigation projects do not involve detailed assessments of different habitat types adjacent to ponds, it was not possible to obtain data on areas of habitat gained or lost.

3.6. Post-development monitoring of newt populations

Out of 72 projects for which this information was available, 35 (49%) included an agreed post-development monitoring period. There were 26 (36%) projects where newts were translocated but monitoring was not done, and a further seven projects where little or no information was provided. Various methods were used for post-development monitoring, although counts by torchlight and egg searches were the most frequently used methods. Equally, results from post-development monitoring were provided in varying degrees of detail, making meaningful comparisons with pre-development surveys and the numbers of newts translocated problematical. Most ponds were monitored for two years or less (Table 4). Although it is clear that great crested newts were observed in ponds post-development, on the basis of current data it is not possible to determine how the populations pre- and post-development compared in size; whether sustainable populations were established; or whether the newts observed represent translocated newts or those that colonized the ponds naturally from elsewhere.

4. Discussion

Since 1990 there has been an almost exponential growth in the number of mitigation projects involving great crested newts in England. Over the survey period there was a general trend towards fewer newts being translocated per project, and the number of ex situ translocations declined in relation to the number of in situ translocations. This pattern probably arose for several inter-related reasons. Firstly, increasing survey effort and improved understanding of survey methods has led to more populations being detected, including many smaller ones. Secondly, awareness of protected species issues has greatly improved among authorities involved in land use planning decisions. This has meant that although the authorities are being alerted to more cases of newt-development conflict, major impacts on newt populations are more frequently 'designed out' at the development planning stage. Consequently, there has been a general trend away from wholesale population translocations, towards maintaining the population within – or adjacent to – the development site. In such cases, the need to translocate a large proportion of the population is reduced.

There are several reasons why in situ translocations may be more appropriate than ex situ translocations for great crested newts. Newts may become disoriented when moved outside their home ranges, or may attempt to return to their original pond. For example, Oldham and Humphries (2000) found that up to 70% of translocated great crested newts attempted to return to their native pond. Homing newts managed to find ponds 500 m from the release site, but none managed to return to home ponds 900 m away. On the other side of the coin, in situ projects are not entirely problem-free. Although maintaining a great crested newt population close to a housing development can have a positive educational value, some respondents to the present survey commented on the risks posed to the population by disturbance, vandalism and other public access effects.

Large-scale and well-planned projects tend to result in larger numbers of newts being translocated. This does not necessarily mean that better organised projects are more 'successful', as proportionally more effort is needed on projects that embrace larger areas or more newt habitat. In a questionnaire survey of translocation practitioners, Reading et al. (1997) found that perceived 'success' was not clearly related to organisational infrastructure, although projects regarded as failures seemed to be less well organized than those regarded as successes. What is much less clear is how the numbers of newts counted both pre- and post-development – as well as the numbers of newts actually translocated – relate to the actual population sizes present. Only one project in our survey attempted to estimate the actual population size. As Schmidt (2003) points out, even if they are standardized, simple counts of amphibians may bear little relationship to actual population sizes because they do not take account of detection probabilities, which vary spatially and temporally. Recent guidelines issued to developers to assist them with conforming to the legislation point out that it is not normally necessary to determine the actual population size, and that an estimate of 'population size class' (i.e. 'small', medium or 'large') based on simple counts can give an indication of the importance of a site providing it is combined with other measures of habitat quality and quantity (English Nature, 2001). Actual population sizes may therefore not always be needed to arrive at conservation assessments, but care is still needed when making comparisons between different sites and between the same site at different times. Moreover, from an ecological viewpoint measuring actual population sizes may be desirable, and can only be ascertained through long-term population studies (Dodd and Seigel, 1991).

Even though it is encouraging that an increasing proportion of great crested newt mitigation projects attempted to maintain existing populations in situ, this was accompanied by a net loss of aquatic and terrestrial habitat. Overall, about half of the ponds that exist on development sites were destroyed. Although the number of new ponds constructed appeared to compensate for the number of known great crested newt ponds lost, new ponds were usually much smaller than those destroyed and data are lacking on how well they have been colonized by newts. Moreover, the creation of smaller ponds did not compensate for the total area of great crested newt aquatic habitat lost to development. Similarly, on average about 27% of newt terrestrial habitat was destroyed during the developments. Although remaining habitat was often enhanced through the provision of refugia and planting of trees, shrubs and grassland, it is unclear how the newt populations responded to such management. Clearly, more data are needed on whether viable great crested newt populations can be maintained within the smaller patches of habitat that are made available for them post-mitigation.

Some 36% of projects that translocated great crested newts were not monitored at all post-development. This is similar to the figure of 31% quoted by Oldham and Humphries (2000) for all projects carried out between 1982 and 1995. Using their minimal criterion of 'success' as at least one newt observed at the receptor site one year following translocation, some 25% of projects comparable to those surveyed here (i.e. not including garden ponds) were 'successful' over the same period (Oldham and Humphries, 2000). However, using the same criterion of 'success' appeared to increase over time, with just 12% of projects successful from 1982 to 1990, and 92% successful from 1991 to 1995. For those projects that were monitored in the present survey, adult newts were observed at 87.5% of sites one year after the translocation, and there was evidence of breeding in 56%. Only three sites were monitored for a period of five years but adult newts and evidence of breeding was observed at all three after this time. Although a relatively high proportion of receptor sites therefore contained breeding great crested newts one or more years post-translocation, these results need treating with caution. As population sizes were not estimated, it is not possible to determine whether the translocated populations – or indeed any in situ populations that remain post-development – represent viable populations that are sustainable in the long-term. Moreover, as it is possible that newts may have colonized many of the receptor sites naturally, it is difficult to distinguish between the effects of natural colonization and translocation in establishing or maintaining populations.

An additional complication when assessing the effectiveness of mitigation is the potential for post-development events to impact on populations. Particular problems for amphibians are the introduction of fish and invasive plants (e.g. Kats and Ferrer, 2003), and the lack of management leading to advanced hydroseral succession. The generally poor level of monitoring means it is difficult to assess the incidence or severity of these factors. This is a key issue, as the value of mitigation schemes needs to be considered in the context of prevailing threats to newt populations. Indeed, just over half of the respondents to the present survey were of the view that the population would be 'stable' in the absence of development, while over a third considered that the population would decline or go extinct even with mitigation. Whether development and mitigation influence the susceptibility of populations to these widespread threats needs to be investigated.

About 5000 great crested newt breeding ponds have been documented in England (Swan and Oldham, 1993; Baker, 2003), although this may represent only 15–30% of the estimated total. The 345 mitigation projects that took place between 1990 and 2001 may therefore have affected some 7% of the known sites. Bearing in mind that other factors – such as lack of habitat management – may affect a high proportion of populations, the impact of mitigation on wider great crested newt conservation depends upon the context within which it is viewed. On the positive side, the fact that an increasing number of populations are being subject to mitigation means that efforts are being made to reduce and compensate for the impact of development on newts at an increasing proportion of known populations. On the negative side, even if a small degree of habitat loss is regarded as an acceptable compromise within many mitigation projects, a continuing exponential growth in the number of projects could lead to a significant overall loss of great crested newt habitat nationally. Whether or not it is possible to maintain 'favourable conservation status' for the species – as required under the Conservation (Natural Habitats &c) Regulations 1994 – under such a scenario will only be determined by further long-term survey.

As pointed out by McLean et al. (1999), European legislation for endangered species has been more effective at countering persecution and some types of direct exploitation than at dealing with the more pressing issues associated with changes in land use. This certainly appears to apply to great crested newt conservation in England. Indeed, under current UK and European legislation, the comprehensive preservation of biodiversity may be frustrated by the emphasis on one species over another, or the failure to address wider ecological issues (Harrop, 1999). However, some of the issues arising from the present survey have been addressed within recent guidelines produced for great crested newt mitigation (English Nature, 2001). For example, the guidelines recommend that mitigation should strive to achieve no net loss of crested newt sites, and bearing in mind that not all newly created ponds may be colonized, in some cases installing twice as many ponds as the number lost may be appropriate. Likewise, there are more rigorous guidelines on the number of years of post-development monitoring that may be needed, based on the size and type of development impact and the population status of the newts present (English Nature, 2001). These guidelines will be subject to a continuous process of revision as new research comes to light, and will hopefully result in mitigation projects that better integrate the legal and ecological requirements of the species.

Acknowledgements

This work was carried out under contract to English Nature. We are indebted to the following who advised on the development of the project and the pilot questionnaire survey: John Baker (Froglife), Dave Bird (British Herpetological Society), Lee Brady (Calumma Ecological Consultants), Ian Bride (DICE), Keith Corbett (HCT), Tony Gent (HCT), Stuart Harrop (DICE), Tom Langton (HCI), Dorian Latham (Ecological Consultant), Gareth Matthes (GPM Ecology/Ecological Planning & Research), Helen Newing (DICE), Rob Oldham (De Montfort University), Kevin Rye (Defra). Jo Oldaker, Heather Ferguson, Judith Murray, Anita Neath and Hazel Walker in the English Nature licensing section assisted with interrogation of the licence files and J. Gerlach and an anonymous referee provided helpful comments on the manuscript. We are also grateful to the many people who completed questionnaires.

References

Baker, J., 2003. Great crested newt pilot monitoring project. R&D Technical Report W1-068/1/TR1, Froglife, Halesworth, UK.

Bloxam, Q.M.C., Tonge, S.J., 1995. Amphibians – suitable candidates for breeding-release programmes. Biodiversity and Conservation 4, 636–644.

Cooke, A.S., 1997. Monitoring a breeding population of crested newts (*Triturus cristatus*) in a housing development. Herpetological Journal 7, 37–41.

Cooke, A.S., 2001. Translocation of small numbers of crested newts (*Triturus cristatus*) to a relatively large site. Herpetological Bulletin 75, 25–29.

Conant, S., 1988. Saving endangered species by translocation. Are we tinkering with evolution?. Bioscience 38, 254–257.

Craven, S., Barnes, T., Kania, G., 1998. Towards a professional position on the translocation of wildlife. Wildlife Society Bulletin 26, 171–177.

Cunningham, A.A., 1996. Disease risks of wildlife translocations. Conservation Biology 10, 349–353.

Dodd Jr., C.K., Seigel, R.A., 1991. Relocation, repatriation and translocation of amphibians and reptiles: are they conservation strategies that work?. Herpetologica 47, 336–350.

English Nature, 2001. Great crested newt mitigation guidelines. English Nature, Peterborough.

Fischer, J., Lindenmayer, D.B., 2000. An assessment of the published results of animal relocations. Biological Conservation 96, 1–11.

Gent, T., Bray, R., 1994. Conservation and management of great crested newts. In: Proceedings of a Symposium held on 11 January 1994 at Kew Gardens, Richmond, Surrey. English Nature Science No. 20, Peterborough.

Green, J., 2000. Working with protected herpetofauna. Environmental Law and Biodiversity. In: Proceedings of the 10th Conference of the Institute of Ecology and Environmental Managers, IEEM.

Griffiths, R.A., 1996. Newts and Salamanders of Europe. T. & A. D. Poyser, London.

Harrop, S.R., 1999. Conservation regulation: a backward step for biodiversity?. Biodiversity and Conservation 8, 679–707.

Hodder, K.H., Bullock, J.M., 1997. Translocations of native species in the UK: implications for biodiversity. Journal of Applied Ecology 34, 547–565.

IUCN, 1995. Guidelines for reintroductions. IUCN, Gland, Switzerland.

JNCC, 2003. A policy for conservation translocations of species in Britain. Joint Nature Conservation Committee, Peterborough, UK.

Kats, L.B., Ferrer, R.P., 2003. Alien predators and amphibian declines: review of two decades of science and the transition to conservation. Diversity and Distributions 9, 99–110.

Marsh, D.M., Trenham, P.C., 2001. Metapopulation dynamics and amphibian conservation. Conservation Biology 15, 40–49.

May, R., 1996. The translocation of great crested newts, a protected species. MSc thesis, University of Wales, Aberystwyth.

McLean, I.F.G., Wight, A.D., Williams, G., 1999. The role of legislation in conserving Europe's threatened species. Conservation Biology 13, 966–969.

Oldham, R.S., Humphries, R.N., 2000. Evaluating the success of great crested newt (*Triturus cristatus*) translocations. Herpetological Journal 10, 183–190.

Oldham, R.S., Musson, S., Humphries, R.N., 1991. Translocation of crested newt populations in the UK. Herpetofauna News 2, 3–5.

Reading, R.P., Clark, T.W., Griffith, B., 1997. The influence of valuational and organizational considerations on the success of rare species translocations. Biological Conservation 79, 217–225.

Schmidt, B., 2003. Count data, detection probabilities, and the demography, dynamics, distribution and decline of amphibians. Comptes Rendus Biologies 326, 119–124.

Swan, M.J.S., Oldham, R.S., 1993. National Amphibian Survey Final Report. English Nature Research Reports number 38, English Nature, Peterborough, UK.

Seigel, R.A., Dodd, C.K., 2002. Translocations of amphibians: proven management method or experimental technique?. Conservation Biology 16, 552–554.