When Development and Amphibians Meet: A Case Study of a Translocation of Great Crested Newts (*Triturus cristatus*) in Sweden

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Abstract.—1 he Great Crested Newt (*Irmurus cristatus*) is considered threatened throughout Europe; consequently, the species and its breeding habitat are protected in many countries. Translocation of a population is a conservation tool used when habitat occupied by a species is scheduled to be destroyed by human development. The outcome of these translocations is rarely monitored. This study describes and discusses a translocation of *T. cristatus* in south-central Sweden (Örebro), which occurred because of planned destruction of breeding habitat associated with development of a shopping and industrial area. We provide quantitative data concerning numbers of relocated amphibians and subsequent monitoring in both the pond being destroyed, which is serving as the source of newts to be translocated, and the pond that received the translocated newts. The translocation exemplifies how difficult it is to determine size and conservation value of a population without thorough initial investigations. A large part of the translocated population seemed to disappear at the receiving area, which initially indicated that the translocation was ineffective. Nevertheless, longer term monitoring indicated that a population was established and reproduced in the new habitat. We argue that translocation should never be a first choice to make human development possible but one should always strive for preservation of an existing habitat. However, if a translocation is unavoidable, an appriopriate assessment of the affected population should be performed and a detailed analysis of habitats in the potential receiving areas should be carried out to select an area best fitted for the species in question.

Key Words.-Amphibia; Caudata; conservation management; introduction; monitoring

INTRODUCTION

Amphibian populations have suffered widespread declines and extinctions during recent decades (Houlahan et al. 2000; Stuart et al. 2004; D'Amen and Bombi 2009). Amphibian declines have been linked to several factors, with habitat destruction as one of the primary causes (Blaustein and Kiesecker 2002; Temple and Cox 2009; D'Amen et al. 2010; Ficetola et al. 2015). Human population growth with associated exploitation of natural habitats, especially close to large towns and cities (i.e., linked to urban sprawl), has rendered conflicts between human and amphibian habitats more common (Price et al. 2006). Conservation measures commonly used to compensate for habitat destruction caused by humans include creation of new habitats, restoration of habitats, and translocation of animals (Dodd and Seigel 1991; Fischer and Lindenmayer 2000; Edgar et al. 2005; Lesbarrères et al. 2010).

Many translocations, human-mediated movement of living organisms from one area, with release in another (International Union for Conservation of Nature/Species Survival Comission 2013), have been performed throughout the world primarily with birds and mammals (Seddon et al. 2005; Germano and Bishop 2009; Goss and Cumming 2013). However, translocation projects with amphibians are increasing, partly becasue of worldwide amphibian declines (Stuart et al. 2004; Mendelson et al. 2006). Even if conservation is central, amphibian translocation projects are most often reactive actions, driven by development pressure (Germano and Bishop 2009). Defective implementation with lack of evaluation on the efficacy of the translocation poses a risk not only to the amphibian speices being translocated, but also to other species that inhabit the release habitat (Griffith et al. 1989; Dodd and Seigel 1991; Seigel and Dodd 2002; Edgar et al. 2005; Germano and Bishop 2009). Indeed, many translocation projects appear to be

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unsuccessful (e.g., Dodd and Seigel 1991; Seigel and Dodd 2002; Germano and Bishop 2009). In particular, translocations initiated because of conflicts between animal (in sense of habitat) and human (e.g., infrastructure or commercial development) interests seem to be prone to failure (Fischer and Lindenmayer 2000; Germano and Bishop 2009; Germano et al. 2015).

The Great Crested Newt (*Triturus cristatus*, Salamandridae), an European amphibian that reproduces in water but inhabits terrestrial environments outside of the breeding period, has been the subject of many translocation projects (e.g. Edgar et al. 2005; Lewis et al. 2007). Typical aquatic and terrestrial newt habitats (ponds and low-intensive mixed agricultural and semi forested landscapes) are among those that have generally decreased through modern land use (Bernes 1994; Ihse 1995; Benton et al. 2003; Biggs et al. 2005; Temple and Cox 2009). The decline of landscape complexity through habitat loss is the largest single reason for decreasing populations of the species (Griffiths et al. 1996; Oldham and Swan 1997; Langton et al. 2001).

Triturus cristatus is listed on Annexes II and IV of the European Community Habitats Directive and Appendix II of the Bern Convention, and is protected under Schedule 2 of the Conservation Regulations 1994 (Regulation 38) and Schedule 5 of the Wildlife and Countryside Act 1981; thus, both the species and its habitats ought to be protected. European Union (EU) countries that are signatories to the Bern Convention are required to enact national legislation that incorporates the requirements of the convention. Consequently, T. cristatus is considered threatened and is protected by law in most European countries. Species action plans have been made in several European countries (UK and Sweden) and for the entirety of Europe to facilitate and guide conservation measures for the species (English Nature 2001; Edgar and Bird 2006; Malmgren 2007). In Sweden, the occurrence of T. cristatus may prevent human exploitation of that site, if the exploitation is not "for consideration of public health and safety or for other dire reasons with an all overshadowing public interest" (Artskyddsförordningen 2007:845, 14§). According to the legislation, exemptions may be made only if there are no other appropriate alternatives to destruction of habitat of the species and if the exemption in itself does not aggravate the achievement of favorable conservation status of the species in its natural distribution area.

Currently, *T. cristatus* and its habitat are legally protected in most European countries (see above). Nevertheless, direct conflict between human interests (e.g., economy) and *T. cristatus* populations has resulted in destruction of the newt habitat and occasionally required extreme actions be taken if a population is to survive. In the UK, nearly 400 translocations of *T. cristatus* were carried out from 1990 to 2004, and the number of annual translocations increased substantially through 2001 (Edgar and Griffiths 2004; Edgar et al. 2005). Griffiths (2004) underlines mismatch between this rapid increase of translocations and the paucity of scientific knowledge aiding the improvement of translocation efficiency. Generally, the discussions concerning the efficiency and possible success of amphibian translocations have been intense, and the criticism against translocations as compensation measures has been harsh (Dodd and Seigel 1991; Reinert 1991; Oldham and Humphries 2000; Marsh and Trenham 2001; Germano and Bishop 2009). Most of the translocations have been performed without any previous enquiries of prerequisites for conservation on site or of other alternatives to translocation. Occassionally, populations have been translocated to areas lacking suitable conditions for the species in question (Edgar et al. 2005; Germano and Bishop 2009). Moreover, monitoring of the population after the translocations is rare; thus, it is difficult to evalute the success of many translocations (Seigel and Dodd 1991; Oldham and Humphries 2000; Edgar et al. 2005; Germano and Bishop 2009). Although many countries are planning for environmentally sustainable development, the conflict between human interests and amphibians will undoubtably exist in the future (Denoël et al. 2013). Therefore, evaluation of success of translocation projects is important for conservation of amphibian populations in general and T. cristatus in particular (Lewis et al. 2007; Germano and Bishop 2009).

In this paper we investigate and discuss ecological and administrative aspects of translocation of a *T. cristatus* population in Örebro County in south-central Sweden. The population was subject to two different translocation projects (1989–1990 and 2007–2008) performed by the Municipality of Örebro. Here, we describe the methods and results of the translocations and subsequent monitoring of the populations using quantitative data. We focus on evaluating the performance of the translocations and propose directions for improvement of future translocation projects.

MATERIALS AND METHODS

Study area.—All translocations that are described in the paper took place in the outskirts of the city of Örebro, which is located in south-central Sweden (Fig. 1). Örebro lies close to the northern distribution limit of the species. Still, in the entire Örebro County (8,546 km²), *T. cristatus* occurs in at least 180 localities (1989–2003; Hellberg et al. 2004), with 40 to 120 estimated breeding populations. The human population of Örebro is increasing; consequently, infrastructure, commercial, and housing development are expanding (Örebro kommun 2010). The local breeding population (an occupied pond surrounded by suitable terrestrial habitat, delimited from



FIGURE 1. Map of the city of Örebro with location of source pond (Marieberg) and receiving areas (Vattenparken and Oset) for a translocated population of the Great Crested Newt (*Triturus cristatus*). The map to the right shows the general location of study area in Sweden. (© Lantmäteriet, I2011/0032).

other suitable habitats) of *T. cristatus* subjected to translocations in this study was originally situated in an abandoned gravel pit, which was largely re-filled with debris and soil-masses (Marieberg; Fig. 2). The aquatic habitat consisted of a pond (surface area approximately 200 m²) at the bottom of the gravel pit. At the time of the second translocation during 2007, the pond was largely overgrown with vegetation (e.g., *Phragmites*, *Typha*, and *Salix*) and surrounded by tall herbs and grasses growing on the debris. There was also a small (approximately 1 ha) forest stand adjacent to the pond dominated by young of deciduous tree species (e.g., *Alnus glutinosa*, *A. incana*, *Betula pendula*, *Populus tremula*, and *Salix* sp.).

To the east and west the gravel pit was bordered by roads, and to the east and north by developed areas. In the south there was a pine-dominated forest, which was scheduled to be replaced by shopping and industrial areas. Other ponds known to serve as breeding sites for *T. cristatus* were situated approximately 1 km to the south and 1 km to the north (Hellberg et al. 2004). However, planned development would have entailed additional isolation of the Marieberg pond from other ponds.

During 1989 and 1990, local herpetologists translocated newts from the gravel pit in Marieberg to an area (Oset) located approximately 10 km to the northeast (Jan Malmgren, unpubl. report; Fig. 1). An artificial pond, approximately 500 m², was constructed in Oset during the late 1980s and is surrounded by pastures and deciduous forest dominated by *A. glutinosa*. During 2007 and 2008, the municipality transocated newts from the Marieberg site to another area (Vattenparken) situated approximately 10 km to the northeast of the original habitat (Fig. 1). Vattenparken is located approximately 900 m from the Oset pond, but the two sites are separated by a river (Svartån). Vattenparken lies in a nature reserve (Rynningeviken) bordering the city of Örebro and consisting of the wetlands along the shores of Lake Hjälmaren (Fig. 2). Several ponds were constructed in this area during the late 1990s for nature conservation, primarily amphibians, without inflow to avoid immigration of fish (Mats Rosenberg, pers. comm.). The pond that received the Marieberg population of *T. cristatus* was approximately 400 m² and in an earlier succession stage than the Marieberg pond. The immediate surroundings of the pond consisted of mowed grassland and wet deciduous forest dominated by *A. glutinosa*.

The forest adjacent to the Marieberg pond had a substantial amount of dead wood, which had been added together with leaf and grass litter to increase the terrestrial habitat quality for newts and other amphibians. Earlier surveys had indicated that there were no *T. cristatus* in the pond or in the surrounding area prior to the translocation (the latest survey prior to translocation was conducted by the County Administrative Board in 2004; Hellberg et al. 2004). However, there was a population of the smaller Smooth Newt (*Lissotriton vulgaris*) in the pond (Hellberg at al. 2004).

Translocation in 1989 and 1990.—Although, the original habitat occupied by *T. cristatus* in Marieberg has been subject to two different translocation projects, in this study we mainly focus on the translocation conducted during 2007 and 2008, with only a short account of the first attempt given below, referring to a project report (Jan Malmgren, unpubl. report).

The reason for the first translocation of T. cristatus during 1989 and 1990 was that their aquatic breeding site, situated in a former gravel pit, was scheduled to be filled with debris and soil. A local nature conservation society applied for permits from the Örebro County Administrative Board to translocate the newt population to a newly constructed pond (Oset). The translocation was carried out for two breeding seasons, 1989 and 1990. Individuals conducting the translocation used dip-nets and captured 121 T. cistatus (65 males, 44 females and 12 juveniles) and photographed all adults to make later identification of individuals possible (Thiemeier and Kupfer 2000). The year after the translocation (1991), T. cristatus was found reproducing in the pond (Malmgren 1991). Unfortunately, no survey was made of the receiving pond before the translocation, so we do not know if T. cristatus inhabited the pond prior to the initial translocation. After 20 y, T. cristatus still inhabited and reproduced in the Oset pond (Daniel Gustafson, pers. obs.).

Translocation in 2007 and 2008.—Due to change in plans, the pond and adjacent terrestrial habitat in the gravel pit in Marieberg was not filled after the translocation in 1989 and 1990. However, in early spring 2007, the Municipality of Örebro received renewed permis-



FIGURE 2. Aerial photos of Marieberg (left) and Vattenparken (right), Sweden. The source and receiving ponds for a translocated population of Great Crested Newts (*Triturus cristatus*), respectively, in the center of the pictures are marked with white. The black circles mark the area within 500 m radius from the center of the ponds. The Oset pond is situated in the bottom right corner of the right photo (marked with white). (© Lantmäteriet, I2011/0032).

sion from the Örebro County Administrative Board to translocate T. cristatus and other amphibians from the Marieberg pond to another area in the vicinity of the city of Örebro (Vattenparken area). The motive for the translocation was that the area where the population habitat was situated was again planned for commercial exploitation. Before the application for translocation permit, the municipality made an inquiry of prerequisites in the area. Because of a short-notice deadline, no survey was made of the Marieberg population before the second translocation. The recommendation to move the population was based on an assumption that the population probably was very small because of the translocations during 1989 and 1990 and on substantial overgrowth and subsequent degradation of the aquatic habitat at Marieberg. An additional argument for translocation was that this local population appeared isolated from other populations, and therefore, was not of particular importance for the regional conservation of the species. The request by the municipality for continued translocation of the population in 2008 was approved. They also obtained a permit to monitor the translocation in the receiving area during 2008 and 2009, and for monitoring both areas during 2014.

The Municipality of Örebro conducted the second translocation during spring and early summer of 2007 and 2008. They used a drift fence, located at a maximum of 2 m from the pond margin, with pit-fall traps (10 L buckets) around the outer margin of the fence to catch newts at the Marieberg pond during spring migration in April (Griffiths and Raper 1994; Arntzen et al. 1995). Migrating newts approaching their aquatic habi-

tat were hindered by the fence and caught in the traps. The fence and traps were monitored daily from 3 April to 20 June 2007 and from 16 April to 30 May 2008 (the fence and traps were removed between years).

Field assistants checked and emptied the pit-fall traps at least once per day. All *T. cristatus* captured were counted and the sex of adults was determined. In addition to *T. cristatus*, all other captured amphibian species (e.g., Smooth Newt, *L. vulgaris*; Common Frog, *Rana temporaria*; Moor Frog, *R. arvalis*; and Common Toad, *Bufo bufo*) were identified to species, counted, and translocated to the same pond in Vattenparken. Snakes and lizards found in traps also were released in Marieberg. All captured amphibians were translocated the same day they were caught. The animals were transported by car in plastic boxes or buckets filled with water from the Marieberg pond, and released in the receiving pond in Vattenparken directly after transport.

Monitoring of the receiving area.—The Municipality of Örebro conducted a monitoring of the amphibians in the receiving pond in Vattenparken from spring to autumn of 2008 and during spring 2009. The monitoring was meant to determine if *T. cristatus* survived in the pond, and if so, how many of the translocated newts remained in the receiving area and if they returned to and bred in the pond. Furthermore, other ponds in the surrounding area were surveyed (Fig. 3), to indicate if the translocated newts had dispersed.

A drift-fence with pit-fall traps, similar to the fence used in Marieberg, was raised around the pond of release and the pits were checked daily from 8 April to 4 Sep-

		Great Cre	sted Newt		Smooth	Common	Moor	Common
Year	Male	Female	Juvenile	Total	Newt	Frog	Frog	Toad
2007	197	433	100	730	159	117	256	3
2008	21	23	15	59	29	18	35	1

TABLE 1. Number of captured and moved individuals of Great Crested Newts (*Triturus cristatus*; males, females, and juveniles) and other amphibians during the translocations from Marieberg to Vattenparken in 2007 and 2008.

tember 2008 and from 9 April to 3 June 2009. In 2008, the pit-fall traps were first situated on the outer side of the drift-fence (16 April to 30 June). From 1 July to 4 September, the pit-fall traps were moved to the inside of the drift-fence, to allow for capturing newts migrating from the aquatic habitat towards the terrestrial habitat after reproduction. During 2009, drift fences with pitfall traps was constructed around two additional ponds in the area (ponds 2 and 3 in Fig. 3) found to be inhabited by T. cristatus during visual observation in 2008. Employees of the municipality and students engaged by the municipality counted all captured T. cristatus, and we determined sex and photographed each adult newt. Also, they counted all other captured amphibians, and released all animals on the other side of the fence after processing.

In addition to the receiving pond, all other ponds in the vicinity (12 ponds, see Fig. 3) were surveyed using standardized visual observation (flashlights; Griffiths et al. 1996; Langton et al. 2001; Malmgren et al. 2005) during two nights in June 2008 and two nights in 2009. Although inappropriate for population size estimates, this is thought to be a reliable and cost-effective method to indicate presence or absence of the species (Kröpfli et al. 2010). Nonetheless, we cannot rule out the possibility of false absences using this method. To confirm if *T. cristatus* were reproducing, the receiving pond at Vattenparken was also surveyed for eggs and larvae, vi-



FIGURE 3. Map of the Vattenparken area, Sweden, with the receiving pond for a translocated population of Great Crested Newts (*Triturus cristatus*; 1) and all surveyed ponds in the surrounding area (2–13). Thick grey lines indicate borders of the nature reserves. (© Lantmäteriet, I2011/0032).

sually and with dip-nets, several times during the late summers of 2007, 2008 and 2009.

During 2014, the Municipality of Örebro again monitored the receiving pond to determine wheter or not it was still inhabited by *T. cristatus*. Because the pond in Marieberg still existed and furthermore had been restored (a decision made by Örebro municipality after discovering the quality of the habitat during 2007 and 2008), they also monitored this pond using the same methods as in 2008 and 2009. Because of an early spring, they constructed and monitored fences and pitfall traps from 14 March to 30 May.

RESULTS

Translocation 2007.—During the spring and early summer of 2007, we captured 730 *T. cristatus* (433 females, 197 males, and 100 juveniles) in the Marieberg pond and translocated them to the Vattenparken pond (Table 1). On the 24-h period with the most intensive migration (16 April to 17 April), municipality employees caught 120 *T. cristatus* (75 females, 39 males, and six juveniles). No *T. cristatus* died during capture or translocation. In addition to *T. cristatus*, they caught 535 individuals of other amphibian species (Table 1). Furthermore, they captured two Grass Snakes (*Natrix natrix*), three Common Lizards (*Zootoca vivipara*), and one Slow Worm (*Anguis fragilis*). Also, they found shrews and voles in the traps, all of which were dead.

Translocation 2008.—During spring and early summer of 2008, municipality employees caught 59 *T. cristatus* in the Marieberg pond (23 females, 21 males, and 15 juveniles) and translocated them to the Vattenparken Pond (Table 1). On the 24-hour period with the most intensive migration (27 April to 28 April), they caught 11 *T. cristatus* (five females, three males, and three juveniles). They found four *T. cristatus* (two males and two females) dead in or close to the pit-fall traps. We do not know the cause of these deaths. Apart from 83 individuals of other amphibian species (Table 1), they did not find other vertebrates in the pit-fall traps.

Monitoring.—Between 16 April and 30 June 2008, municipality employees caught 49 *T. cristatus* in Vattenparken as they were migrating from their terrestrial habitat to the pond and subsequently released them on



FIGURE 4. The different stages of the translocation and subsequent monitoring of a population of the Great Crested Newt (*Triturus cristatus*). The population was translocated from its original habitat in Marieberg during two years (2007 and 2008) and surveyed during the two consecutive years at the receiving pond in Vattenparken, Sweden. The receiving pond in Vattenparken was surveyed again during 2014.

the other side of the fence (Table 2, Fig. 4). In addition to amphibians, they caught 13 Grass Snakes and one vole. Between 1 July and 4 September 2008, they caught 197 *T. cristatus* exiting the pond. Of these, 108 individuals were juveniles, and one was dead. Furthermore, they caught five Grass Snakes, 18 shrews, and six voles.

From 9 April to 3 June 2009, municipality employees caught 224 *T. cristatus* immigrating to the three fenced ponds (Ponds 1–3 in Fig. 3) in the Vattenparken area, with 181 newts migrating towards Pond 1. They found *T. cristatus* inhabiting an additional two ponds (Ponds 12 and 13, Fig. 3) during the visual survey conducted in 2009. They found eggs and larvae of *T. cristatus* in Pond 1 during 2007 and 2008, but no evidence of reproduction by this species in any pond during 2009. Between 14 March and 28 May 2014, municipality employees caught 789 *T. cristatus* immigrating to the pond in Vattenparken (Table 2, Fig. 4), including 226 juveniles. In addition to amphibians, they found three dead shrews and three dead voles in the traps.

From 14 March to 28 May 2014 municipality employees caught 1,044 *T. cristatus* (441 males, 557 females, and 76 juveniles) at Marieberg during spring migration towards their aquatic habitat. Moreover, they captured 338 individuals of *L. vulgaris*, 333 *Rana* spp. and 61 *B. bufo*. In addition to amphibians were caught four Common Lizards, one shrew, and five voles. The shrew and voles were dead.

DISCUSSION

During the translocation project in 2007, the population size of T. cristatus at the source pond in Marieberg, Örebro was larger than expected. The local population size was substantially underestimated. Before translocation, the habitat was deemed as not optimal for T. cristatus, which was a main argument for the translocation. Because of short notice and pressure from land developers, surveys could not be performed prior to the decision to allow for translocation of amphibians and planned destruction of the habitat. Nevertheless, the number of individuals caught during spring migrations of 2007 and 2008 show that the local population in Marieberg was very large, despite previous translocation during 1989 and 1990. Although heavily disturbed, the terrestrial habitat surrounding the Marieberg pond apparently is also sufficient to support a sizable population of newts. Furthermore, 6 y after the translocation, the remaining and restored pond was monitored, showing a remarkable recovery of the population in Marieberg. Even though 789 individuals had been translocated from the pond, more than 1,000 individuals have been found during one year of monitoring.

This study clearly exemplifies that an estimate of population size based on ad hoc assessed habitat quality is unreliable and should not be used as a criterion for translocation. The massive over-growth of the aquatic habitat in Marieberg indicated that it was rather in a late successional stage and may have deteriorated in recent years. However, *T. cristatus* may live for as long as 16 y (Thiesmeier and Kupfer 2000), and a population might linger in an area for years, even in sub-optimal habitats incapable of supporting successful reproduction (Dolmen 1982; Thiesmeier and Kupfer 2000). The relatively large number of individuals caught by dip-netting during 1989 and 1990, considered a poor method for sampling *T. cristatus* (Griffiths et al. 1996; Langton et al. 2001), should have been a signal that the population was

TABLE 2. Number of captured individuals of Great Crested Newts (*Triturus cristatus*; males, females, and juveniles) and other amphibians during the monitoring of a translocation receiving pond in Vattenparken in 2008, 2009, and 2014. Asterisk (*) is the total number found for either *Rana* frog because species were not identified in 2009 or 2014.

	Great Crested Newt				Smooth	Common	Moor	Common
Year	Male	Female	Juvenile	Total	Newt	Frog	Frog	Toad
2008 spring	7	25	18	50	76	35	49	19
2008 autumn	29	60	108	197	82	7	28	10
2009	31	87	63	181	167	296*	*	37
2014	204	353	232	789	183	161*	*	26

larger than expected. Furthermore, a survey of population size should have been performed prior to deciding on translocation as a conservation tool at this locality.

There are some major sources of concern when considering the results of the monitoring procedure and the outcome of the translocation. First, the individuals that were moved in the 2008 and 2009 translocation were not photographed, making it impossible to judge if the individuals found in Vattenparken in the following years originated from the translocation. There could have been a natural colonization of Pond 1 after the translocation. As no detailed pre-translocation surveys of Pond 1 were conducted, there is also a possibility that T. cristatus inhabited the pond in Vattenparken prior to the release of the individuals from Marieberg. Nonetheless, we believe that the lack of observations of the species in the well-visited Vattenparken and the large number of individuals introduced from Marieberg during the translocation suggests that T. cristatus in Pond 1 is a result of the translocations.

One should be cautious when claiming success of a translocation project (Dodd and Seigel 1991). Denton et al. (1997) proposed that success for restoration of amphibian habitats should be estimated as: (1) initial success, the emergence of metamorphs from ponds; (2) intermediate success, return of adults to breed for the first time; (3) complete success, continuation of breeding for 5 y; or (4) failure, adults fail to return after 5–10 y. Long-term monitoring is therefore necessary to distinguish if the translocation project is a success with respect to site sustainability and population size. This is particularly important when working with a relatively long-living species such as *T. cristatus*.

Fewer individuals showed up at Pond 1 in Vattenparken during the 2008 breeding season than were translocated in 2007. The reason for the potential decrease in adult population size is unknown. Nonetheless, the large number of juveniles migrating from this pond in the late summer probably originated from successful reproduction during 2008. No breeding was confirmed during 2009. The reasons for this reproduction failure are unclear. However, we suggest that the population is inceasing or remaining stable because during 2014 almost the same number of individuals were captured, that were translocated during 2007 and 2008.

There can be several possible reasons for the large decline in population size observed directly after the translocation in Örebro. Newt populations are reknowned for fluctuating between years, so the decrease could be due to a host of natural or unnatural drivers (Kupfer and Kneitz 2000; Malmgren 2001). However, the new and un-familiar environment in Vattenparken combined with the stress of the translocation may have caused elevated mortality or emigration from the area; losses linked to such conservation measure are expected (Teixeira et al. 2007). Another set of problems that must be dealt with in translocation projects is the behavior of the individuals. Adult T. cristatus tend to use the same aquatic and terrestrial habitat from year to year (Kupfer and Kneitz 2000; Oldham and Humphries 2000; Malmgren 2001). Individuals translocated experimentally are able to find their way back to the original area (Jehle 2000; Thiesmeier and Kupfer 2000). This tendency for homing possibly explain the presence of the species in the ponds surrounding the receiving pond in Vattenparken, where T. cristatus were found in at least four other ponds where they had not been present before the translocation. The most common reason for failure of amphibian and reptile translocation projects is homing and migration of introduced individuals away from the release site (Germano and Bishop 2009).

There is also a risk that the quality of the receiving pond was overestimated. However, the increase of the population six years after translocation indicates that the habitats in Vattenparken is sufficient for longer-term survival and breeding of T. cristatus. Possibly, because ecological succession in newly established ponds is characterized by a high amplitude of changes (Louette et al. 2008), the receiving pond with time attained higher quality as breeding habitat. The evaluation of receiving habitat quality is of particular importance in the translocation process. The factors to consider include not only physical, chemical, and biological characteristics, but also spatial considerations (e.g., juxtaposition in the landscape; Angelibért et al. 2004; Scheffer and van Geest 2006; Gustafson et al. 2009; Hartel et al. 2010). A typical habitat for the T. cristatus seems to be a moderately shallow pond or small lake that holds abundant vegetation and supports a diverse invertebrate fauna (Swan and Oldham 1993; Sztatecsny et al. 2004; Gustafson et al. 2006; Denoël and Ficetola 2008). However, in the case of semi-aquatic organisms like T. cristatus, not only aquatic but also terrestrial habitat must be considered. Terrestial environments inhabited by T. cristatus include forests with a high content of deciduous trees, semi-natural pastures, and rough grasslands (Griffiths 1996; Thiesmeier and Kupfer 2000; Gustafson et al. 2011). This species apparently prefers environments with a high coverage in the field vegetation layer or with a high quantity of substrate like leaf litter, boulders, and logs on the ground (Jehle 2000; Jehle and Arntzen 2000; Vuorio et al. 2015). Before a translocation is performed, it should be confirmed that all or at least most of these criteria are fulfilled by the receiving locality and that aquatic and terrestrial habitats are sufficiently interconnected to make movements between them possible (Swan and Oldham 1993; Jehle 2000; Joly et al. 2001; Malmgren 2002).

Although animal translocations may in some cases be an alternative method for preserving amphibian populations, the best option is almost always to preserve the population in situ. This is particularly important when considering amphibians because their habitats have been continuously removed and neglected in many landscapes. Several studies have shown that ponds in different stages of succession are valuable for maintaining biodiversity, which makes even seemingly deteriorated habitats valuable (Friday 1987; Semlitsch and Bodie 1998; Linton and Goulder 2000; Williams et al. 2003; Oertli et al. 2005). Furthermore, lack of knowledge on both aquatic and terrestrial habitats of many amphibian species often makes it difficult to calculate the conservation value of individual ponds without appropriate surveys.

In the case of Marieberg, the importance of the pond as a habitat for amphibians including T. cristatus, was not sufficiently assessed before the translocation. However, after realizing that the source pond and its surroundings was an important amphibian habitat with a large population of T. cristatus, the municipality decided to preserve and even enhance it. The pond was cleared from overgrowing vegetation, pond surface enlarged and slopes along the shores downgraded. Unfortunately, this decision was made after the translocation had already been performed. The decision to preserve the source pond may serve as an example of adaptive management, potentially helpful in cases when data are insufficient and the outcome uncertain. However, probably a more costeffective solution would have been an initial assessment of conservation value and preservation of the population in its original habitats.

A population of T. cristatus was successfully established at a new location in Vattenparken in Örebro. The large number of translocated newts likely provided a foundation for the population at a new locality (Germano and Bishop 2009; Zeisset and Beebee 2013). Instead of one population of T. cristatus, the unintentional outcome of the project was the establishment of two large populations in the region. The translocation described in this article was performed in 2007 and 2008. Today, mechanisms to prevent destruction and exploitation of T. cristatus populations and habitats have been introduced both in Sweden and other European countries. Nevertheless, translocation may be perceived as an established and humane conservation strategy by the general public and by legislators and government agencies (Dodd and Seigel 1991; Reinert 1991; see also Reading et al. 1997). Still, it is important to note potential risks and high costs associated with translocations and such projects must be thoroughly evaluated before the actual translocation can be made (Dodd and Seigel 1991; Seigel and Dodd 2002). Planning and implementation of translocation projects should preferably not be carried out under pressure from developers (Dodd and Seigel 1991; Trenham and Marsh 2002). Moreover, it is important to communicate methods and results of such translocation attempts to both scientists and to the general public (Dodd and Seigel 1991; Germano et al. 2015). Without information from both successful and failed translocations, decision makers and conservation managers may have difficulties in discerning urgency of a project and in selecting appropriate translocation techniques.

Acknowledgments.—The translocation was performed and financed by the municipality of Örebro and performed with permission from the Örebro County Administrative Board. Part of the monitoring in 2008 and 2009 was performed by students from Örebro University and Stockholm University. We kindly acknowledge financial support from the School for Forest Management, Faculty of Forest Sciences, Swedish University of Agricultural Sciences.

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