Translocation as a conservation tool to supplement relict bat colonies: A pilot study with endangered horseshoe bats

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ABSTRACT

Animal relocation has become an important tool in conservation biology. Little is known about the suitability of translocation to restore bat populations. We tried to assess the conditions for successful translocations in two highly endangered bat species in Switzerland: the greater horseshoe bat (*Rhinolophus ferrumequinum*) and the lesser horseshoe bat (*Rhinolophus hipposideros*). Both species underwent a dramatic decline in Western and Central Europe in the second half of the 20th century but populations have recently started to recover in some regions, e.g. Switzerland. Due to their very sedentary habits, recolonization of their formerly vast inhabited range advances extremely slowly. In 2006, we conducted translocation experiments with eleven greater horseshoe bats and seven lesser horseshoe bats within Switzerland. Bats were captured from large and healthy colonies and individually released into relict colonies. Animals were radiotracked for up to ten days. Of the 13 individuals released at distances < 20 km from their native roost, eleven showed immediate homing behaviour. Of the five animals released at distances > 40 km, none expressed homing tendencies. Within the first three days after release, one greater and one lesser horseshoe bat were predated, whilst two lesser horseshoe bats died due to shock. Although sample size in lesser horseshoe bats remains small, it appears that this species reacts very sensitive to translocation. In contrast, long-distance translocation of greater horseshoe bats led to apparent short-term settlement in the releasing area, suggesting that supplementation may prove an interesting conservation tool for this species. Further investigations are needed to evaluate whether these settlements may be definitive.

KEY WORDS: Translocation, supplementation, *Rhinolophus ferrumequinum, Rhinolophus hipposideros*

1. INTRODUCTION

Relocation is the general term for the intentional release of animals in order to establish, re-establish or augment populations in the wild (IUCN 1987, 1995). So far, relocations were mainly used to establish populations of non-native species, to solve human-animal conflicts, to supplement game or fish populations or to restore native species extirpated by hunting (Griffith *et al*. 1989; Fischer and Lindenmayer 2000). In recent years, however, the practice of relocating animals has become an important tool in conservation biology. The total number of relocations that are conducted yearly is not known and much information remains unpublished (Dodd and Seigel 1991; Hodder and Bullock 1997). The lack of information is attributed to a failure to monitor released animals (Dodd and Seigel 1991; Wolf *et al*. 1996), insufficient project duration (Beck B. *et al*. 1994), reluctance to report failures and/or outcomes being published in non peer-reviewed journals (Sarrazin and Barbault 1996). Relocations are undertaken either with wild animals (translocation) or with captive-reared animals. The IUCN (1987, 1995) distinguishes between three different classes of relocations: introduction, reintroduction, restocking / supplementation. Introduction is the intentional or accidental release of a species outside of its historically known range. Introductions are often undertaken for economic or recreational benefits (Kleiman 1989) and can impose a severe threat to native species due to interspecific competition (Bertram & Moltu 1986). Reintroduction is the intentional release of an organism into a part of its native range from which it has disappeared or become extinct in historic times. Restocking / supplementation are the terms used for the release of organisms with the intention of increasing the population in an original habitat. The ultimate goal of reintroductions or supplementations in conservation biology is to reconstitute viable populations (Griffith *et al*. 1989; Stanley Prize 1991). The criteria of success for these relocations have not been standardized so far. Seddon (1999) proposes an evaluation of success divided into three parts: a) survival of the release generation, b) breeding by the release generation and its offspring and c) persistence of the re-established population. On the other hand, relocations can under some circumstances pose a severe threat to the species that already inhabit the area where animals are released (Warner 1968; Spalding and Forrester 1993; McCallum and Dobson 1995, Cunningham 1996; Deem *et al*. 2001; Ryser-Degiorgis *et al*. 2002; Appendix II).

In small populations, potential benefits of supplementation include a) increasing the population size, b) increasing genetic diversity, c) reducing inbreeding depression and d) establishing self-sustainable populations (Scott 1987). Essential for any evaluation are thus short- and long-term post-release monitoring. Keys to successful reintroductions and supplementations include suitable habitat, sufficient habitat protection and/or restoration, elimination of factors of the cause of the decline and an appropriate choice of the release site (Kleiman 1989; Fischer and Lindenmayer 2000). A review of published studies of 116 animal relocation attempts revealed that only 26% were successful, whereas 27% failed whilst for 57% the outcome was not clear yet (Fischer and Lindenmayer 2000).

Even though bats have been translocated through natural and accidental means (Lina 1984, 1986, 1990; Constantine 2003; Appendix III), there have been very few deliberate translocations of bats (Kramer 1971; Richarz 1989; Constantine 2003; Long 2003). Probably the most successful attempt so far was undertaken in April 2005, when 20 captive-born lesser short-tailed bats (*Mystacina tuberculata*) were released on Kapiti Island, New Zealand (Ruffell 2006). Juveniles were used in order to overcome the homing instinct in adult bats, experienced in a previous translocation of the same species (Anderson unpublished; Lloyd unpublished). At least nine bats stayed and survived on the island at least 234 days after release. However, captive breeding, soft-release technique and supplementary feeding were time and resources consuming.

Bats play an important role in ecosystem functioning e.g. insect pest control and pollination (Feldhamer *et al.* 2003). Even though they are able to adapt to various environments, populations are negatively affected by environmental perturbations, both natural and human-induced ones. As a result, many of the about 1000 worldwide recognized species are threatened by loss of habitats, food shortage, exposure to pesticides and direct human exploitation (Mickleburgh *et al.* 2002; IUCN red list data base 2007). The same pattern can be observed in Switzerland where all of the about 30 extant bat species, except two, are red-listed. Among them are the greater horseshoe bat (*Rhinolophus ferrumequinum*) and the lesser horseshoe bat (*Rhinolophus hipposideros*). Since the 1950's, these two bat species have undergone a severe decline in Central and Western Europe (Roer 1983/84; Stebbings and Arnold 1989; Duvergé 1996). The same drastic trend was recorded in Switzerland. There, the greater horseshoe bat was once widespread although never very common (Zingg 1982). Its populations shrank during the last century and today only four isolated populations remain in the country. The largest colony has around 200 individuals (Castrisch, Canton Grison). Other smaller colonies occur in Vex and Pfynwald (Canton Valais) and in Wegenstetten (Canton Aargau). The lesser horseshoe bat was once a common and abundant bat species (Furrer 1957; Zingg 1982). Today, only some isolated populations remain in some regions of the Alps (Stutz and Haffner 1984). Of 93 once known occupied nursery roosts, only 37 were still inhabited in 1999 (Bontadina and Arlettaz 2000). The most likely potential causes of decline of greater horseshoe bats are pesticides, habitat changes, food shortage, loss and deterioration of roosts (Stebbings and Arnold 1989; McAney 1994; Bontadina *et al.* 2002), whereas the main factor of decline for lesser horseshoe bats in Switzerland is likely to the be the past use of organochlorinated pesticides for timber treatment in attics (Bontadina *et al.* 2006; Arlettaz *et al.,* unpublished). The fact that most populations of both species are now expanding in Switzerland suggests that the causes of decline have been largely eliminated, which may result from the banning of organochlorinated pesticides in the 1970's.

Both horseshoe bat species exhibit sedentary habits, being loyal to their summer and winter roosts (Issel 1950; von Helversen *et al.* 1987). The greater horseshoe bat forages usually within 3 – 4 km of the summer roost although distances up to 15 km have been recorded (Jones and Morton 1992; Jones *et al.* 1995; Duvergé 1996; Bontadina 2002). Winter and summer roosts may lay 10 – 60 km apart from each other (Roer 1960; Roer 1967; Kepka 1960; Hutterer *et al.* 2005). Few individuals have been recorded as far as 120 km, however (Roer 1960; Stebbings and Arnold

1987; von Helversen *et al.* 1987). Lesser horseshoe bats usually forage within a 2.5 km radius from the nursery roost (Bontadina *et al.* 2002) with distances up to 5 km (Schofield 1996; Holzhaider *et al.* 2002). Summer and winter roosts lie usually within 1 km to one another, sometimes being even in the same building (Roer 1960; Harmata 1992). Ringing studies revealed movements up to 20 km with exceptional movements of up to 150 km (Issel 1950; Kepka 1960; Gaisler *et al.* 1969; Harmata 1992; Hutterer *et al.* 2005). Previous homing experiments have shown that lesser horseshoe bats find their roost when released within a radius of 8 km and up to 24 km from their native roost in Germany and Poland, respectively (Issel 1950; Davis 1966). In both species, exchanges between colonies are rare (S. Rossiter, pers. comm.; R. Ransome pers. comm.). Finally, the reaction of local horseshoe bats towards immigrants is not known.

During intensive monitoring of lesser horseshoe bats in the last 15 years in Switzerland, a population increase could be assessed, but expansion by colonization of new areas and roosts was not observed. Natural recolonization of former range could be hampered by the fragmented nature of the habitat matrix, with many isolated bat populations.

The question arises whether the translocation of free-ranging individuals of large and growing colonies into small relict colonies could accelerate population expansion and help mitigating the traditional symptoms typical of small populations (Scott and Carpenter 1987; Lande 1988; Frankham 2005).

The aim of this study was therefore to assess the feasibility of individual translocation as a potential tool for supplementing relict bat populations, using the endangered lesser and greater horseshoe bats as models. The behaviour of the bats within the release site was observed in order to detect possible agonistic interactions between resident bats and the newly incomer bat. In order to evaluate the short-term translocation success we monitored emergence behaviour of the released bats, survival and location of day-roosts and foraging grounds of these individuals within a few days after release.

2. MATERIAL & METHODS

2.1 Donor colonies

Donor colonies were selected based on the following criteria: a) population size > 50 adults and b) positive population trend during the past five years. We selected one colony of greater horseshoe bats in Vex (Canton Valais, 46°12′ N, 7°23′ E, 961 m altitude, n = 59 adults in 2005) and four colonies of the lesser horseshoe bats: Kleinteil (Canton Obwalden, 46°49′ N, 8°9′ E, 589 m altitude, n = 315), Giswil (Canton Obwalden, 46°50′ N, 8°11′ E, 539 m altitude, n = 66), Latterbach (Canton Bern, 46°40′ N, 7°34′ E, 820 m altitude, n = 66) and Blumenstein (Canton Bern, 46°43′ N, 7°30′ E, 833 m altitude, n = 108).

2.2 Receiver colonies

For the releases of the greater horseshoe bats two relict colonies with only few individuals were chosen: Pfynwald (Canton Valais, 46°18′ N, 7°36′ E, 616 m altitude, n = 2 adults in 2005) and Wegenstetten (Canton Aargau (47°29′ N, 7°55′ E, 488 m altitude, n = 5 adults in 2005). The former site was 18 km, the latter one 149 km distant from the donor roost. In lesser horseshoe bats, release sites were selected among small populations (< 45 adults in 2005): Brienzwiler (Canton Bern, 46°44′ N, 8°5′ E, 729 m altitude, n = 44 adults in 2005) and Wilen (Canton Obwalden, 46°52′ N, 8°13′ E, 554 m altitude, n = 33 adults) (Table 1).

2.3 Capture and marking

Greater horseshoe bats were captured in May, July and September 2006 at the donor roost. The animals were mist-netted either at emergence on the initial flight paths to foraging grounds or upon early morning return. Mist–netting was also performed at the entrance to a cave used as day roost. Lesser horseshoe bats were captured in June and August 2006 either with mist-nets during dusk emergence or with a hand net within the nursery roost after sunrise. During the period of late pregnancy and early lactation, no animals of either species were captured in order to avoid disturbance. All captured animals were sexed, measured and the reproductive status was assessed. As all the greater horseshoe bats of the donor colony have been systematically ringed since 1989 (Schaub *et al*. in press), their precise age could be determined. Only healthy bats were chosen for the translocation. Bats were ringed and fitted with a radio transmitter (Holohil Systems Ltd, Carp, Ontario, Canada), which was attached to the fur between the shoulder blades with Skinbond™, a latex-based and biodegradable surgical glue. Adult and subadult greater

horseshoe bats were equipped with BD-2P transmitters (1.0 g, activity switch, 28 days life expectancy). Lesser horseshoe bats and juvenile greater horseshoe bats were equipped with BD-2N transmitters (0.43 g, no activity switch, 14 days life expectancy). Forearm rings and transmitters were covered with colour reflecting tape to enable visual recognition from a distance.

2.4 Translocation, monitoring and short-term tracking

Captured animals were kept in bags or cages for transportation to the receiver nursery roost where they were released as soon as possible after dawn. The behaviour of some bats after release was monitored until dusk emergence (n = 2 greater horseshoe bats and 4 lesser horseshoe bats) by infrared video recording (video camera: Videotronic, CCD-7012P, Neumünster, Germany; video recorder: Sanyo, TLS 9924P, Osaka, Japan with a 10 picture/sec time-lapse; infrared LED light: MFL-I/LED6, 80 Watt). The camera was pointed towards the area where most bats roosted. After dusk, the bats were radiotracked the whole night by a single person, equipped with an Australis receiver, directional 2 H-antenna (RA-14K, Telonics Inc., Mesa, USA) or a vehicle-mounted omnidirectional antenna (HL-M881H, Hotline GmbH, Mannheim, Germany). Foraging areas were located by homing in towards highest amplitude signals (White and Garrott 1990). Coordinates of the bearings were taken with GPS (eTrex Summit, Garmin International Inc., Olathe, USA). In some instances, bats were observed visually using a torch with a red light filter or detected with a bat detector (Mini-3 Bat detector, Ultra Sound Advice, London, UK). Individuals were followed for up to 10 nights in a row, radio-monitoring was restricted to three nights when they homed successfully. Locations of day roosts were assessed until transmitter failed, was removed or when the bat died.

2.5 Analysis

Translocations were grouped into two classes: < 20 km and > 40 km (Table 1). The direction of the travel movement was analysed using the Chi-Square test of number of moves into each of four quadrants after travel movement was detected. Speed of flight of greater horseshoe bats was calculated from the time of emergence until the animal crossed an imaginary border of their colonial home range (4 km radius from the nursery colony). Statistics are presented as means ± standard error (SE).

3. RESULTS

Greater horseshoe bats

Eleven greater horseshoe bats were translocated (Appendix I). Four adults and five juveniles were translocated over an aerial distance of < 20 km whilst two subadults were released > 40 km away. Video filming was conducted for the two subadult bats, totalling 320 min of sequences, with only 12 seconds with visible bats: the introduced bat was accompanied by a resident bat close to which it hang but no body contact or agonistic behaviour could be observed.

Emergence was slightly delayed in the first night following release compared to the emergence in the subsequent evening: 27.5 min (range: -4 - 82 min; n = 11) (Table 3). Only one greater horseshoe bat used the release site as a night roost during the first night after release most probably due to heavy rainfall immediately after release. All nine bats translocated < 20 km showed homing tendencies. Directed travel movement was recognized starting, on average, 126 min ($\pm$ 45.4; n = 9) after the first night emergence. Travel directions were not randomly distributed (χ^2 = 20.25, p < 0.05, df = 3), with the approximate direction being towards their native roost. Eight of these nine bats homed successfully within the first night after release. Time span between emergence and entering supposed core home range of the colony averaged 173.5 min $\pm$ 40.8 min SD (n = 8), resulting in a mean flight speed of 7.7 km/h $\pm$ 2.2 km/h with a maximum speed of 21 km/h. All adult bats that homed did not use their native nursery roost for at least two days, whereas three juveniles returned to it immediately after homing and one returned to the nursery roost during the second night after release. After having homed, the bats foraged within a radius of 3.9 km from their nursery colony roost, which corresponds to their colony home range (Jones *et al.* 1995; Lugon 1996).

The two subadult bats released > 40 km stayed in the surroundings of the release site until the end of their radio tracking sessions (Table 2). Additionally, one juvenile bat (< 20 km) expressed homing tendencies but turned around to install itself close to the release site. None of the three bats that remained in the surroundings of the release area used the release site as day roost. Instead they chose buildings in the proximity of it. For these three animals, roosts and foraging areas were mainly outside of the estimated colony home range (Table 2). During the tracking sessions, the subadult bats frequented only one roost, for both day and night roosting. Of the translocated eleven bats, one died before the end of the radiotracking session, on day 3. Its body was found on the ground partially eaten. Predation is suspected.

Lesser horseshoe bats

Seven lesser horseshoe bats were translocated (Appendix 1). Three adults and one juvenile bat were translocated < 20 km, one adult and two subadults were released > 40 km aerial distance from their native roosts (Tables 1 and 3). For four bats, a total of 650 min of video material was obtained, with 146.20 min showing the focal bat. Altogether, five interactions could be recorded: in four cases, a flying resident bat approached the sleeping translocated bat. Although agonistic behaviour cannot be entirely excluded, none of the translocated bats took off during or immediately after the approach. In one sequence, an introduced lesser horseshoe bat attached itself to the cluster of resident bats for few seconds before hanging itself very close to the cluster without any noticeable agonistic behaviour from the residents.

Emergence was, like in greater horseshoe bats, slightly delayed in the first night following the release compared to the emergence in the subsequent evening: 20 min (range: -6 - 30 min; n = 6) (Table 3). With one exception, all lesser horseshoe bats translocated < 20 km showed homing tendencies. Directed travel movement was detected in two animals with subsequent successful homing: in one case 85 min after emerging in the first night, and in the other case immediately after emerging from a cave in the vicinity of the release site on the second night. Bats which didn't home immediately chose caves and buildings at maximum distances of 1.8 – 2.6 km from the release site. Four lesser horseshoe bats stayed in the surroundings of the release site until the end of their radio tracking sessions (n = 3 > 40 km, n = 1 < 20 km) (Table 2). None of these bats used their release site as day roost but chose instead buildings, caves and crevices in the proximity of it. However, one bat used the release site as a night roost during the first night after release most probably due to heavy rainfall immediately after release. They roosted and foraged within the estimated colony home range (Table 2).

Of the seven translocated bats, three animals died (on day 1, 2 and 3, respectively) during the short-term monitoring. Two bats died during daytime with the diagnosis being shock caused by stress (Institute for Pathology, Vetsuisse, University of Bern). The other bat died during night time and its body was found already partially eaten. The precise cause of death could not be determined but predation is suspected.

4. DISCUSSION

Although short-termed, our experiments suggest that translocation of horseshoe bats may be suitable for supplementing populations. However, some conditions must be fulfilled: a) donor populations are not threatened and large-sized, b) the factors causing the decline have been eliminated and c) habitat suitability is ascertained in the release area (Kleiman 1989; Fischer and Lindenmayer 2000). In both species, agonistic behaviour between resident bats and the new incomer could not be evidenced, although information remains scarce. This differs remarkably from the reactions of Bechstein's bats which attack fiercely intruders (Kerth *et al*. 2002).

Emergence just after release at the receiver roost was delayed in most individuals when compared with the subsequent evenings. Translocated individuals that stayed in the release area did not use the release site as a day roost once they had emerged. Two subadult lesser horseshoe bats and one subadult greater horseshoe bat used as day roosts buildings located on the way to foraging grounds (A. Beck and A. Theiler, pers. comm.) of the colonies where they were released into. Moreover, the two subadult lesser horseshoe bats used the same building as day roost for at least the first three days after release. Even though the two subadult greater horseshoe bats that remained loyal to the distant release site stayed outside the estimated colony home range, short-term monitoring suggests that translocation could be successfully achieved. One of the subadult greater horseshoe bats settled 9.9 km from the release site with main foraging areas only 2 km aerial distance from the main hibernation cave of the resident population, the other subadult greater horseshoe bat chose a day roost as well as foraging grounds which had been formerly used by radio-tracked greater horseshoe bats of the recipient colony in 1996 (Beck and Schelbert 1999; A. Beck, pers. comm.). Among the greater horseshoe bats released < 20 km from their native nursery roost, all but one showed clear homing tendencies, which resulted in 91% successful homing performance. The two lesser horseshoe bats that had homed successfully, had to pass a mountain ridge at 1000 m altitude, about 300 m higher than the release and receiver sites in order to return to their native colony home range. Homing tendencies in mammals can be strong and have been observed until 11 months after release (Conover 2002). Some bat species are good homers, e.g. the red bat (*Lasiurus borealis*) in North America and the Noctule bat (*Noctula noctula*) in Europe, migrating over thousands km distances from the summer to the winter territories (Schmidt-Koenig 1975). Homing experiments with bats showed that also nonmigratory species can home over long distances: for instance, at least 4.5% of translocated big brown bats (*Eptesicus fuscus*) travelled 724 km within a month after release (Smith and Goodpaster 1958). For most mammals, the shortest possible distance for a successful translocation is considered typically 5 to 10 times the width of an individual home range (Conover 2002; M. Conover, pers. comm.). Colony range in greater horseshoe bats is estimated to be within a radius of 4 km around the nursery roost (Jones *et al*. 1995; Beck A. *et al*. 1994a; Bontadina 2002) although dispersion to winter sites reached up to 36 km. Dispersal from greater horseshoe bats of the colony in Vex has been documented up to 27.4 km (Lugon 1996). Many

of the translocated adult greater horseshoe bats might already have been familiar with the terrain around our release site, distant of 18 km from the donor colony. However, juveniles were most probably unfamiliar with the release area since they expand their home range gradually with age (Jones *et al*. 1995; Duvergé 1996). The surprisingly high homing success rate of the juvenile greater horseshoe bats (80%) suggests the existence of a spatial orientation mechanism in bats, e.g. earth magnetic field (Holland *et al*. 2006) or visual orientation (Mueller and Emlen 1957; Williams and Williams 1967; Schmidt-Koenig, 1975; Schober and Grimmberger 1998).

The variation in homing velocity was large because most individuals foraged on the way home. An estimated maximum flight speed of 21 km/h corroborates the figures by Stebbings (1982). Once individuals returned to the surroundings of their native nursery roosts, they stayed within colony home range during the entire radiotracking session. Interestingly, all adults that homed did not use their native nursery roost for roosting during at least a minimum of three nights after release, whereas the most of the homed juveniles used the nursery roost immediately after return. Additionally, the juvenile greater horseshoe bat that remained in the release area had great difficulties to find a suitable day roost, finally settling more than one hour after sunrise. These observations may indicate a strong reliance on the native roost in juvenile horseshoe bats. It is possible that juvenile bats gradually learn to identify new suitable roosts, making them therefore more vulnerable at an early stage of dispersal, especially when exposed to new environments.

In our experiments three lesser horseshoe bats (43%) and one greater horseshoe bat (9%) died within three days after release. Translocating wild animals involves frequent handling by people, e.g. capture, transmitter attachment, transportation and release all of which are likely to induce stress (Williams and Thorne 1996; Jung *et al*. 2002). In various projects, our group previously radiotracked 52 greater horseshoe bats during a total of 211 days and 51 lesser horseshoe bats during a total of 203 days without any sign of mortality during sessions (Beck A. *et al*. 1994a; Beck A. *et al*. 1994b; Bontadina *et al*. 1995; Lugon 1996; Bontadina *et al*. 1997; Bontadina *et al*. 2002; Bontadina *et al*. 2006; Reiter *et al*., unpublished). Therefore, this high mortality rate is unlikely to be attributable only to capture, marking and radiotracking of the bats. Environmental stress has been recognised to have a larger impact than handling stress on early survival after translocation (Letty *et al*. 2000). In the case of the two lesser horseshoe bats, shock due to the stress of a new environment is likely to be the cause. Also, in an unfamiliar habitat, exposure to predators is enhanced where suitable roosts lack or which are not yet localized by the translocated animal. Furthermore, cold and rainy weather in 2006 might have weakened the lesser horseshoe bats: an abnormally high mortality rate of about 25% in lesser horseshoe bat yearlings was observed in some Swiss colonies (A. Theiler and P. Zingg, pers. comm.).

5. CONCLUSIONS

Although we could monitor bats' behaviour only in the short-term, i.e. during a few days after release, there seems to be a potential for successful translocation in horseshoe bats. A certain minimum translocation distance (> 40 km) appears crucial for overcoming the apparently strong homing tendencies combined with their sense of geographical orientation. Handling or storing duration might influence bats' behaviour, thus the time in captivity should be kept as short as possible. As juveniles rely heavily on their native nursery roost, this age class should be excluded from translocations. Lesser horseshoe bats appear extremely susceptible to stress and stress-related mortality and/or vulnerable to predation when facing a new environment. Translocation of the lesser horseshoe bat species appears thus very problematic. On the contrary, this pioneer study suggests that translocation of greater horseshoe bats might be prone to success. Further investigations are needed to evaluate whether settlement in the receiving population is permanent (Seddon 1999).

6. ACKNOWLEDGMENTS

REFERENCES

BECK A., BONTADINA F, GLOOR S. HOTZ T., LUTZ M. and MÜHLETHALER E. 1994a. Preliminary results regarding activity pattern and foraging areas of *Rhinolophus ferrumequinum* in an alpine valley of Switzerland. Bat Research News **35**: p. 16

BECK A., BONTADINA F., GLOOR S., HOTZ T. and SCARAVELLI D. 1994b. Preliminary results on the ecology of *Rhinolophus ferrumequinum* in Romagna (northern Italy). Università degli Studi di Pisa e Siena, Pisa, 12 pp.

BECK A. and SCHELBERT B. 1999. Neue Nachweise der Grossen Hufeisennase im Kanton Aargau. Untersuchungen zum Lebensraum und Konsequenzen für den Schutz. Mitteilungen der Aargauischen Naturforschenden Gesellschaft Mitteilungen **35**: 93 - 113

BECK B.B., STANLEY PRICE M.R. and WILSON A.C. 1994. Reintroduction of captive-born animals. Pages 265 – 286 *in* Creative Conservation: Interactive management of wild and captive animals. Edited by P.J.S. Olney, G.M. Mace and A.T.C. Feistner. Chapman & Hall, London, 552 pp.

BERTRAM B.C.R. and MOLTU D.P. 1986. Reintroducing red squirrels into Regents-Park. Mammal Review **16**: 81 - 88

BONTADINA F., BECK A., GLOOR S., HOTZ T., LUTZ M. and MÜHLETHALER E. 1995. Jagt die grosse Hufeisennase *Rhinolophus ferrumequinum* im Wald? – Grundlagen zum Schutz der letzten grösseren Kolonie in der Schweiz. Der Ornithologische Beobachter **92**: 325 – 327

BONTADINA F., HOTZ T., GLOOR S., BECK A., LUTZ M. and MÜHLETHALER E. 1997. Schutz von Jagdgebieten von *Rhinolophus ferrumequinum*. Umsetzung der Ergebnisse einer Telemetrie-Studie in einem Alpental der Schweiz. Pages 33 – 39 *in* Zur Situation der Hufeisennasen in Europa. Edited by Arbeitskreis Fledermäuse Sachsen-Anhalt e.V., IFA-Verlag GmbH, Berlin, 182 pp.

BONTADINA F. and ARLETTAZ R. 2000. *Rhinolophus hipposideros* 2000. Research program for the conservation of the lesser horseshoe bat *Rhinolophus hipposideros* in Switzerland. Swiss Coordination Centre for the Study and Protection of Bats, Zürich and Geneva, 21 pp.

BONTADINA F. 2002. Conservation ecology in the horseshoe bats *Rhinolophus ferrumequinum* and *Rhinolophus hipposideros*. PhD Thesis, University of Bern, Switzerland, 184 pp.

BONTADINA F., SCHOFIELD H. and NAEF-DAENZER B. 2002. Radio tracking reveals that lesser horseshoe bats (*Rhinolophus hipposideros*) forage in woodland. Journal of Zoology. **258**: 281 - 290

BONTADINA F., HOTZ T. and MÄRKI K. 2006. Die Kleine Hufeisennase im Aufwind. Ursachen der Bedrohung, Lebensraumansprüche und Förderung einer Fledermausart. Haupt Verlag, Bern, 79 pp.

CONOVER M.R. 2002. Wildlife translocation. Pages 211 – 228 *in* Resolving human-wildlife conflicts: the science of wildlife damage management. Lewis Publishers, Boca Raton, Florida, 418 pp.

CONSTANTINE D.G. 2003. Geographic translocation of bats: known and potential problems. Emerging Infectious Diseases **9**: 17 – 21

CUNNINGHAM A.A. 1996. Disease risks of wildlife translocation. Conservation Biology **10**: 349 – 353

DAVIS R. 1966. Homing performance and homing ability in bats. Ecological Monographs **36**: 201 - 237

DEEM S.L., KARESH W.B. and WEISMAN W. 2001. Putting theory into practice: wildlife health in conservation. Conservation Biology **15**: 1224 - 1233

DODD C.K. JR. and SEIGEL R.A. 1991. Relocation, repatriation, and translocation of amphibians and reptiles: are they conservation strategies that work? Herpetologica **47**: 336 – 350

DUVERGÉ P.L. 1996. Foraging activity, habitat use, development of juveniles, and diet of the greater horseshoe bat (*Rhinolophus ferrumequinum* – Schreber 1774) in south-west England. PhD Thesis, University of Bristol, UK, 324 pp.

FELDHAMER G.A., DRICKAMER L.C., VESSEY S.H. and MERRITT J.F. 2003. Mammalogy: Adaptation, diversity, and ecology. The McGraw Hill Companies, New York, 550 pp.

FISCHER J. and LINDENMAYER D.B. 2000. An assessment of the published results of animal's relocations. Biological Conservation **96**: 1 – 11

FRANKHAM R. 2005. Genetics and extinction. Biological Conservation **126**: 131 - 140

FURRER M. 1957. Ökologische und systematische Übersicht über die Chiropterenfauna der Schweiz. PhD Thesis, University of Zürich, Switzerland, 87 pp.

GAISLER J. and HANAK V. 1969. Summary of the results of bat-banding in Czechoslovakia, 1948 – 1967. Lynx **10**: 25 - 34

GRIFFITH B., SCOTT J.M., CARPENTER J.W. and REED C. 1989. Translocation as a species conservation tool: status and strategy. Science **245**: 477 – 480

HARMATA W. 1992. Movements and migrations of lesser horseshoe bat, *Rhinolophus hipposideros* (Bechst.) (Chiroptera, Rhinolophidae) in south Poland. Zeszyty Naukowe Uniwersytetu Jagiellonskiego; Prace zoologiczne **39**: 47 - 60

HODDER K.H. and BULLOCK J.M. 1997. Translocations of native species in the UK: implications for biodiversity. Journal of Applied Ecology **34**: 547 - 565

HOLLAND R.A., THORUP K., VONHOF M.J., COCHRAN W.W. and WIKELSKI M. 2006. Bat orientation using Earth's magnetic field. Nature **444**: p. 702

HOLZHAIDER J., KRINER E., RUDOLPH B.U. and ZAHN A. 2002. Radio-tracking a Lesser horseshoe bat (*Rhinolophus hipposideros*) in Bavaria: an experiment to locate roosts and foraging sites. Myotis **40**: 47 – 54

HUTTERER R., IVANOVA T., MEYER-CORDS C. and RODRIGUES L. 2005. Bat migrations in Europe: A Review of Banding Data and Literature. Bundesamt für Naturschutz, Bonn, 176 pp.

ISSEL W. 1950. Ökologische Untersuchungen an der Kleinen Hufeisennase (*Rhinolophus hipposideros* (BECHSTEIN)) im mittleren Rheinland und unteren Altmühltal. Zoologische Jahrbücher, Abteilung für Systematik, Ökologie und Geographie der Tiere **79**: 71 - 86

IUCN 1987. Translocation of living organisms: introduction, reintroductions and re-stocking. *IUCN Position Statement*, Gland, Switzerland, 8 pp.

IUCN 1995. IUCN / SSC Guidelines for re-introductions. 41st Meeting of the IUCN Council, Gland, Switzerland, 5 pp.

IUCN 2007. Red list data base: www.iucnredlist.org

JONES G. and MORTON M. 1992. Radio-tracking studies on habitat use by greater horseshoe bats (*Rhinolophus ferrumequinum*). Pages 521 - 537 *in* Wildlife Telemetry. Remote monitoring, monitoring and tracking of

animals. Edited by I.G. Priede and S.M. Swift. Ellis Horwood, Chichester, xii + 708 pp

JONES G., DUVERGÉ P.L. and RANSOME R.D. 1995. Conservation biology of an endangered species: field studies of greater horseshoe bats. Symposia of the zoological Society of London **67**: 309 - 324

JUNG T.S., THOMPSON I.D., HICKEY M.B.C. and TITMAN R.D. 2002. Apparent capture myopathy in Hoary bats, *Lasiurus cinereus*: a cautionary note. The Canadian Field-Naturalist **116**: 136 – 137

KEPKA O. 1960. Die Ergebnisse der Fledermausberingung in der Steiermark vom Jahr 1949 bis 1960. Bonner Zoologische Beiträge **11**: 54 – 76

KERTH G., SAFI K. and KÖNIG B. 2002. Mean colony relatedness is a poor predictor of colony structure and female philopatry in the communally breeding Bechtein's bat (*Myotis bechsteinii*). Behavioral Ecology and Sociobiology **52**: 203 - 210

KLEIMAN D.G. 1989. Reintroduction of captive mammals for conservation. BioScience **39**: 152 – 161

KRAMER R.J. 1971. The Hawaiian bat (*Lasiurus cinereus semotus*). Pages 55 – 69 *in* Hawaiian land mammals. Charles E. Tuttle Company, Rutland, Vermont, 347 pp.

LANDE, R. 1988. Genetics and Demography in Biological Conservation. Science **241**: 1455 - 1460

LETTY J., MARCHANDEAU S., CLOBERT J. and AUBINEAU J. 2000. Improving translocation success: an experimental study of antistress treatment and release method for wild rabbits. Animal Conservation **3**: 211 - 219

LINA P.H.C. 1984. Vermoedelijke verplaatsing van Nathusius' dwergvleermuizen *Pipistrellus nathusii* door houttransporten van Polen naar Nederland. Lutra **27**: 154 – 156

LINA P.H.C. 1986. Een geval van passieve verplaatsing van Nathusius' dwerg-vleermuis *Pipistrellus nathusii* van Nederland naar Engeland. Lutra **29**: 241 – 242

LINA P.H.C. 1990. Passieve verplaatsing van Kuhl's dwergvleermuis *Pipistrellus kuhlii* van Italië naar Nederland. Lutra **33**: 49 – 50

LONG J.L. 2003. Introduced mammals of the world: their history, distribution and influence. CABI Publishing, Oxon, UK, 589 pp.

LUGON A. 1996. Ecologie du Grand Rhinolophe, *Rhinolophus ferrumequinum* (Chiroptera, Rhinolophidae) en Valais (Suisse): Habitat, régime alimentaire et stratégie de chasse. Master thesis, University of Neuchâtel, Switzerland, 116 pp.

MCANEY C.M. 1994. The lesser horseshoe bat in Ireland – past, present and future. Folia Zoologica **43**: 387 - 392

MCCALLUM H. and DOBSON A. 1995. Detecting disease and parasite threats to endangered species and ecosystems. Trends in Ecology and Evolution **10**: 190 – 194

MICKLEBURGH S.P., HUTSON A.M. and RACEY P.A. 2002. A review of the global conservation status of bats. Oryx **36**: 18 - 34

MOSILLO M., HESKE E.J. and THOMPSON J.D. 1999. Survival and movements of translocated raccoons in northcentral Illinois. Journal of Wildlife Management **63**: 278 – 286

MUELLER H.C. and EMLEN J.T. JR. 1957. Homing in bats. Science **126**: 307 – 308.

RICHARZ K. 1989. Report of the successful transplantation of a nursery colony of the lesser horseshoe bat (*Rhinolophus hipposideros*) and remarks about the actual status of this species in Bavaria. Pages 659 – 670 *in* European Bat Research 1987. Edited by V. Hanak, I. Horacek and J. Gaisler. Charles University Press, Praha, 718 pp.

ROER H. 1960. Vorläufige Ergebnisse der Fledermaus-Beringung und Literaturübersicht. Bonner Zoologische Beiträge **11**: 234 - 263

ROER H. 1967. Wanderungen der Fledermäuse. Pages 102-119 *in* Die Strassen der Tiere. Edited by H. Hediger. Friedr. Vieweg & Sohn, Braunschweig, 313 pp.

ROER H. 1983/84. Zur Bestandssituation von *Rhinolophus ferrumequinum* (Schreber, 1774) und *Rhinolophus hipposideros* (Bechstein, 1800) im westlichen Mitteleuropa. Myotis **21–22**: 122 – 131.

RUFFELL J.P. 2006. Translocation of lesser short-tailed bats (*Mystacina tuberculata*) to Kapiti Island: an assessment of release site suitability, translocation success, and factors affecting roost-tree selection following release. Master thesis, University of Auckland, New Zealand, 114 pp.

RYSER-DEGIORGIS M.-P., LUTZ H., BAUER K., SAGER H., RYSER A., ZIMMERMANN F., BREITENMOSER-WÜRSTEN CH. and BREITENMOSER U. 2002. Veterinary supervision of lynx translocation within the Swiss Alps. Pages 147 – 153 *in* Proceedings of the European Association of Zoo- and Wildlife Veterinarians (EAZWW), 4th scientific meeting, joint with the annual meeting of the European Wildlife Disease Association (EWDA) May 8 – 12, 2002, Heidelberg, Germany, 531 pp.

SARRAZIN F. and BARBAULT R. 1996. Reintroduction: challenges and lessons for basic ecology. Trends in Ecology and Evolution **11**: 474 – 478.

SCHAUB M., GIMENEZ O., SIERRO A. and ARLETTAZ R. Enhanced estimates of population dynamics obtained from limited data using integrated modeling. Paper in press: Conservation Biology

SCHMIDT-KOENIG K. 1975. Migration and homing in animals. Zoophysiology and Ecology, Volume 6. Springer-Verlag, Berlin, 99 pp.

SCHOBER W. and GRIMMBERGER E. 1998. Die Fledermäuse Europas. Kosmos Naturführer, 2. Auflage, Stuttgart, 265 pp.

SCHOFIELD H.W. 1996. The ecology and conservation biology of *Rhinolophus hipposideros*, the lesser horseshoe bat. PhD Thesis, University of Aberdeen, UK, 197 pp.

SCOTT J.M. and CARPENTER J.W. 1987. Release of captive-reared or translocated endangered Birds: What do we need to know? The Auk **104**: 544 – 545

SEDDON P.J. 1999. Persistence without intervention: assessing success in wildlife reintroductions. Trends in Ecology and Evolution **14**: p. 503

SMITH E. and GOODPASTER W. 1958. Homing in nonmigratory bats. Science **127**: p. 644

SPALDING M.G. and FORRESTER D.J. 1993. Disease monitoring of free-ranging and released wildlife. Journal of Zoo and Wildlife Medicine **24**: 271 - 280

STANLEY PRICE M.R. 1991. A review of mammal re-introductions, and the role of the Re-introduction Specialist Group of IUCN/SSC. Symposia of the zoological Society of London **62**: 9 - 25

STEBBINGS R.E. 1982. Radio tracking greater horseshoe bats with preliminary observations on flight patterns. Symposia of the zoological Society of London **49**: 161 - 173

STEBBINGS R.E. and ARNOLD H.R. 1987. Assessment of trends in size and structure of a colony of the greater horseshoe bat. Symposia of the zoological Society of London **58**: 7 – 24

STEBBINGS R.E. and ARNOLD H.R. 1989. Preliminary observations of 20th Century changes in distribution and status of *Rhinolophus ferrumequinum* in Britain. Pages 559 - 563 *in* European Bat Research. Edited by V. Hanak, I. Horacek and J. Gaisler. Charles University Press, Praha, 718 pp.

STUTZ H.P. and HAFFNER M. 1984. Arealverlust und Bestandesrückgang der Kleinen Hufeisennase *Rhinolophus hipposideros* (Bechstein, 1800) (Mammalia: Chiroptera) in der Schweiz. Jahresbericht der Naturforschenden Gesellschaft Graubünden **101**: 169 – 178

VON HELVERSEN O., ESCHE M., KRETZSCHMAR F. and BOSCHERT M. 1987. Die Fledermäuse Südbadens. Mitteilungen des badischen Landesvereins für Naturkunde und Naturschutz **14** (N.F.): 409 - 475

WARNER R.E. 1968. The role of introduced diseases in the extinction of the endemic Hawaiian avifauna. The Condor **70**: 101 – 120

WHITE G.C. and GARROTT R.A. 1990. Analysis of wildlife radio-tracking data. Academic Press, San Diego, 383 pp.

WILLIAMS E.S. and THORNE E.T. 1996. Exertional Myopathy (Capture Myopathy). Pages 181 - 193 *in* Noninfectious diseases of wildlife. Edited by A. Fairbrother, L.N. Locke and G.L. Hoff. 2nd Edition. Manson Publishing, London, 219 pp.

WILLIAMS T.C. and WILLIAMS J.M. 1967. Radio tracking of homing bats. Science **155**: 1435 – 1436

WILLIS C.K.R, BRIGHAM R.M. and GEISER F. 2006. Deep, prolonged torpor by pregnant, free-ranging bats. Naturwissenschaften **93**: 80 - 83

WOLF C.M., GRIFFITH B., REED C. and TEMPLE S.A. 1996. Avian and mammalian translocations: update and reanalysis of 1987 survey data. Conservation Biology **10**: 1142 – 1154

ZINGG P.E. 1982. Die Fledermäuse (Mammalia, Chiroptera) der Kantone Bern, Freiburg, Jura und Solothurn: Systematische und geographische Übersicht zu den bisher gesammelten und beobachteten Chiropteren. Master thesis, University of Bern, Switzerland, 149 pp.

TABLES

Table 1. Number of individuals used for translocation with information on the donor and the receiver colonies with respect to colony size and distance between them (GHB=Greater horseshoe bat; LHB=Lesser horseshoe bat).

Species	Number of individuals	Donor colony	Colony size (maximum adults in 2005)	Receiver colony	Colony size (maximum adults in 2005)	Distance capture - release location
GHB	9	St. Sylve, Vex	59	Pfyngut	43	18 km
GHB	2	St. Sylve, Vex	59	Wegenstetten	5	148.6 km
LHB	3	Militärpavillon, Giswil	66	Brienzwiler	44	12.3 km
LHB	1	Blumenstein	108	Brienzwiler	44	44.3 km
LHB	1	Latterbach	66	Wilen	33	54.3 km
LHB	1	Blumenstein	108	Wilen	33	56.8 km
LHB	1	Kleinteil, Giswil	315	Brienzwiler	44	10.5 km

Table 2. Translocated animals that remained for > 1 night in the release area, indicating the maximal distances between foraging grounds and chosen roost site.

Species	Distance capture - release location	Immediate translocation success[1]	Reason for failure	Maximal distance release site to foraging areas	Maximal distance release site to chosen roost	Mean distance to foraging areas	Mean distance to roosts
GHB	> 40 km	+		1.3 km	0.2 km		
GHB	> 40 km	+		10.4 km	9.9 km		
GHB	< 20 km	-	death (3rd night)	5.2 km	4.7 km	5.6 km	4.93 km
LHB	< 20 km	-	death (2nd night)	0.4 km	0.46 km		
LHB	< 20 km	-	homing (2nd night)	0.6 km	0.26 km		
LHB	> 40 km	-	death (3rd night)	1.5 km	1.47 km		
LHB	> 40 km	+		0.8 km	0.25 km		
LHB	> 40 km	+		0.3 km	0.25 km	0.7 km	0.54 km

[1] + = success; - = failure

Table 3. Time of emergence for 11 greater horseshoe bats and 6 lesser horseshoe bats from the day of release and subsequent night.

Greater horseshoe bats

Ring code	Night 1	Night 2	Difference in minutes
A1 107	21.47	21.09	38
M 960	21.19	21.12	7
M 164	21.16	21.15	1
M 155	21.39	21.00	39
A1 092	23.17	21.54	82
A1 194	22.10	21.34	36
A1 659	21.55	20.28	17
A1 666	21.16	20.00	76
A1 685	20.15	20.01	14
A1 677	19.46	19.50	-4
A1 680	19.55	19.55	0
Mean			**27.8**

Lesser horseshoe bats

Ring Code	Night 1	Night 2	Difference in minutes
W018	22.49	22.55	-6
W023	21.38	21.20	18
W024	22.30	22.00	30
W049	22.33	21.10	23
X986	21.34	21.05	29
W010	21.50	21.24	26
Mean			**20**

Table 4. Calculated flight speed in homing greater horseshoe bats.

Ring code	Distance km	Time until nature home range area reached (min)	km/h
A1 107	14	298	2.81
M 960	14	72	11.64
M 164	14	40	20.95
M 155	14	364	2.30
A1 659	14	117	7.16
A1 685	14	105	7.98
A1 677	14	148	5.66
A1 680	14	244	3.43
Mean		**173.5**	**7.7**
SE		**± 40.8**	**± 2.2**

APPENDICES

Appendix I

Summary of radiotracking data on eleven greater horseshoe bats and seven lesser horseshoe bats.

Rind code	Sex[1]	Age class[2]	Reproductive status	Translocation Distance	Intensive radiotracking session	Nights of radio tracking	Nights with contact
A1 107	F	A	Pregnant	18 km	12.5.-15.5.06	3	3
M 960	F	A	Pregnant	18 km	15.5.-18.5.06	3	3
M 164	F	A	Pregnant	18 km	18.5.-20.5.06	2	2
M 155	F	A	Pregnant	18 km	22.5.-24.5.06	2	2
A1 092	F	S		148.6 km	13.7.-21.7.06	9	6
A1 194	M	S		148.6 km	24.7.-31.7.06	8	5
A1 659	M	J		18 km	1.9.-4.9.06	4	4
A1 666	M	J		18 km	6.9.-9.9.06	3	3
A1 685	M	J		18 km	9.9.-11.9.06	3	3
A1 677	M	J		18 km	19.9.-21.10.06	3	3
A1 680	F	J		18 km	19.9.-21.10.06	3	3
						43	37
W018	F	A	pregnant	12.3 km	5.6.-7.6.06	2	2
W023	F	A	pregnant	12.3 km	8.6.-11.6.06	3	3
W024	F	A	pregnant	12.3 km	12.6.-15.06.	2	2
W049	F	A	pregnant	44.3 km	17.6.-20.6.	3	3
X986	F	S		56.8 km	4.8.-8.8.06	3	3
W010	F	S		54.3 km	11.8.-14.8.	3	3
W031	M	J		10.5 km	18.08.06	0	0
						16	16
					Total	60	53

[1] F = Female; M = Male
[2] A = Adult; S = Subadult; J = Juvenile

Appendix II

Relocated animals may carry new parasites, which can result in undesirable consequences to the resident population, to other resident species at the site of translocation or to both (McCallum *et al.* 1995; Warner 1968). So has the rapid spread of rabies in raccons in the eastern United States been linked to the translocation of nuisance animals that carried the disease (Mosillo *et al.* 1999). Also, immunologically naïve animals may be released into an area where potentially pathogenic parasites are endemic (Cunningham 1996). Additionally, the relocation procedure itself can cause stress and injuries, which may enhance an outbreak of a disease in the relocated animal (Ryser-Degiorgis *et al.* 2002). Endemic diseases are eliminated from populations once the population size falls below a critical level required for the maintenance of such diseases. Such populations become immunologically naïve and are at a greater risk of being affected by previous-endemic diseases (Cunningham 1996). Endangered species with their usually small population sizes will therefore acquire virulent infectious diseases only after exposure to infected hosts (McCallum *et al.* 1995). It was proposed that a) all relocated animals should be screened for known pathogens, b) animals that die post-release should also be necropsied and c) parasites foreign to the release area should be eliminated prior to translocation. So far only few data sets on health parameters on endangered or threatened species exist. If no diseases are recorded for the species in question, it does not mean that this species is not susceptible to disease (Cunningham 1996). Hence data should be collected on various health parameters in order to be able to perform health surveys or assessments and long-term health monitoring (Deem *et al.* 2001; Spalding *et al.* 1993). Spalding *et al.* (1993) conclude that the importance of diseases in wildlife has been greatly underestimated especially for endangered species and reintroduction projects.

Appendix III

Natural translocation can occur when bats that migrate along coastlines and are blown far out to the sea. Species such as the hoary bat (*Lasiurus cinereus*), red bat (*Lasiurus borealis*), seminole bat (*Lasiurus seminolus*) and the silver-haired bat (*Lasionycteris noctivagans*) have been found occasionally up to 1000 km far away from their original migratory path on islands. Accidental translocation occurs when bats flying far at sea alight on ships and are transported to unintended destinations, when bats roost in or on ships in port and are transported as a consequence, when bats roost or hibernate in shipping containers, when bats roost in trucks and when bats are closed inside aircrafts (Constantine 2003; Lina 1990, 1986, 1984). Apparently several attempts to introduce bats on the Hawaiian Islands were made in the late 19th Century. In 1897, an unknown number of asiatic pipistrelle bats from Japan and 600 free-tailed bats (*Tadarida brasiliensis*) from California were released on the Hawaiian Islands for insect control. None of the introductions proved successful (Kramer 1971). In 1930, a pair of greater horseshoe bats (*Rhinolophus ferrumequinum*) was released in the County of Monaghan, UK. Another 9 greater horseshoe bats were released in the Regent's park London, UK in 1933 by G. Seccombe Hett (Long 2003). During World War II, field trials were conducted with bats to determine the effectiveness of dispersing thousands of free-tailed bats (*Tadarida brasiliensis*) in air, each transporting a small time-activated firebomb or dummy bomb. These animals were released up to 1609 km away from their origin roosts, but nothing is known about their survival (Constantine 2003). A short-time successful roost translocation of 6 lesser horseshoe bats (*Rhinolophus hipposideros*) of a colony consisting of 15 individuals was conducted in May 1984 in Peissenberg Germany due to the following destruction of the nursery roost. Counts in 1986 revealed up to 13 individuals in the substitute roost, but subsequently the colony vanished (Richarz 1989; Richarz, pers. com.).