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Survivorship of rehabilitated juvenile Tawny Owls (*Strix aluco*) released without support food, a radio tracking study

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ABSTRACT

We investigated the survival of 57 rehabilitated juvenile Tawny Owls (*Strix aluco*) that were 'hard released' (without the provision of a release aviary or support food) by means of radio tracking. The birds were released in the month of August in three consecutive years: 2005, 2006 and 2007, in the counties of Somerset and Hampshire, United Kingdom. Tracking of the owls was successfully carried out for between three and 160 days. Mortality was recorded for 16 birds (28%). The transmitter was shed by 24 (42%) owls, the signal was lost for 12 (21%) and tracking was ceased for five (9%) owls. Survival of the owls was compared with results from previous studies on wild Tawny Owls and also rehabilitated 'soft released' Tawny Owls (released with provision of food and shelter after release) and found to be similar. This study suggests that employing costly and time-consuming soft release techniques may be unnecessary for juvenile Tawny Owls as their survival is not significantly reduced using hard-release methods. Measuring post-release success of rehabilitated birds of prey is discussed in relation to benchmarks used in previous studies.

Keywords: *rehabilitation, hard release, soft release, Tawny Owls,* Strix aluco, *survival, juvenile, radio track*

1. INTRODUCTION

The primary goal of wildlife rehabilitation is to achieve the optimum welfare outcome for the animal(s) concerned. It is often time consuming and expensive, and carries a risk to animal welfare as treatment, handling and captivity are likely to cause stress (Teixeira *et al.*, 2007). Evaluating the success of wildlife rehabilitation efforts is therefore essential to justify the rationale and motivation that underpins the process. An obvious and useful indicator of a successful rehabilitation outcome is survival through a pre-determined post-release time frame. Monitoring the post-release survival of juveniles is particularly important because this age class of animal is naïve to natural habitats and likely to be inexperienced at foraging and evading potential predators.

Tawny Owls (*Strix aluco*) are the most numerous owl in the United Kingdom (Snow and Perrins, 1998) and are regularly admitted as casualties to rehabilitation centres. For instance, between 1994 and 2003, 2,177 Tawny Owls were admitted to four RSPCA wildlife Centres in England and accounted for 55.5% of all owl admissions (RSPCA unpublished data). A substantial percentage of these (22%) was nestlings, fledglings and uninjured juveniles. Young Tawny Owls tend to leave the nest after approximately 30 days, before they are fully-fledged (Southern, 1970), when they may be found (apparently helpless) on the ground by well meaning passers-by.

These juvenile Tawny Owls are often returned to the wild successfully. Of the 479 admitted to the centres in the 10 year period described above, 67% (321) were released back to the wild (RSPCA, unpublished data). This is significantly higher than the 42% release rate for adults (RSPCA, unpublished data), which is probably due to the fact that adults are often seriously injured or very sick before they are discovered and collected by passers-by.

Survival to the point of release is one aspect of rehabilitation success, but equally important is survival after release. Yet compared to release rates, relatively little information exists on the post-release survival of rehabilitated birds of prey (Csermely, 2000b).

Leg-band recoveries can provide information on post-release survival, but this method is often compromised by low recovery rates. For example, Leighton *et al.* (2008) had a ring recovery rate of only 16% from

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a total of 112 Tawny Owls ringed. Martell *et al.* (2000), in a larger review of both diurnal and nocturnal raptors, had post-rehabilitation recovery data for just 8% of ringed birds, and suggested that a more thorough investigation of rehabilitation success required a technique other than ring returns.

The use of radio telemetry (for both wild and rehabilitated owls) enables a relatively accurate assessment of survival to be made. Radio-tracked birds can sometimes be lost to tracking efforts, but rates of loss are far lower than in ring-recovery studies. Radio-tracking has been the primary method of assessment for studying the survival of juvenile Tawny Owls released after rehabilitation. Most studies have had relatively small sample sizes and covered only one season, which limits the usefulness of survival estimates. For example, Bennett and Routh (2000) radio-tracked four juvenile Tawny Owls, three for at least 30 days, and observed one death. Their conclusion was that short-term survival (75%) was sufficient to justify the rehabilitation process. Csermely (2000a) tracked eight juvenile Tawny Owls for 7–79 days, recorded only one death by predation and drew a similar conclusion to Bennett and Routh (2000). More recently, in a larger group of 16 juvenile Tawny Owls, Leighton *et al.* (2008) reported a survival rate of at least 37% six weeks after release.

Studies on the survival of wild juvenile Tawny Owls from fledgling age throughout the dependency period (2.5–3 months; Newton, 1979) shows wide variation, ranging from 8.3% (Petty and Thirgood, 1989) to 97.2% (Southern *et al.*, 1954). Within this range, Coles and Petty (1997) reported 36% survival prior to dispersal (40–106 days after fledging), Overskaug *et al.* (1999) 61% and Sunde (2005) 36%. Where mortality was high, predation was a significant factor.

Some of the variation in post-release survival in rehabilitated Tawny Owls may derive from different release methods. Some studies have used a 'soft release' that utilises a release pen provisioned with food (Bennett and Routh, 2000; Leighton *et al.*, 2008), and this method is often used to relocate and reintroduce a range of species (Teixeira *et al.*, 2007). This method is intended to allow the owls time to become accustomed to the release environment and be provisioned with food until they begin hunting. Providing post-release food may be warranted, as Coles and Petty (1997) observed at least six cases of death by starvation in wild juvenile Tawny Owls, suggesting that food is a limiting factor, although their study was conducted during the low point of the vole cycle. In addition to providing food, a 'soft release' allows birds time to settle in a release aviary, familiarise themselves with local sights and sounds, and choose their own time of departure once the aviary has been opened. This could have significant effects on both the stress levels at the time of release, as animals are allowed time to recover from handling and transport (Molony *et al.*, 2006), and the initial behaviour of the animals, as they might be less likely to disperse to unsuitable areas (*e.g.* Dickens *et al.*, 2009).

However, there is some evidence that the support provided in a 'soft release' is not always utilised by released Tawny Owls. Many birds leave the release pen almost immediately and do not return, or even consume the food that is provided (Bennett and Routh, 2000; Leighton *et al.*, 2008; Murn, unpublished data). It may be that juvenile Tawny Owls do not require post-release support and can be returned to the wild using a 'hard release'. Being able to successfully release Tawny Owls using a 'hard release' has important time and cost saving implications. It would be beneficial to all rehabilitators of Tawny Owls if it could be demonstrated that survival, and by extension welfare, were not compromised by the use of a 'hard release' technique.

In this study we investigated the post-release survival of 'hard released' Tawny Owls released over three seasons without habituation to the release site or the provision of post-release support food. We compared survival with wild Tawny Owls studied by Coles and Petty (1997) and we also compared survival with a meta-analysis of 'soft released' Tawny Owls studied by Leighton *et al.* (2008) and Bennett and Routh (2000).

2. METHODS

Between 2005 and 2007, 57 Tawny Owls were admitted as pre-fledged juveniles to the RSPCA West Hatch Wildlife Centre in Somerset, UK and the Hawk Conservancy Trust near Andover in Hampshire, UK. Initial housing consisted of small cages ($30 \times 30 \times 50$ cm) and owls were fed twice daily on a diet of whole dead day-old chicks and/or mice supplemented with an electrolyte mix (AVIMIX, Vetark Animal Health, Winchester, England). Most owls could self-feed on admission and were reared in a small creche with one or two other owlets. Very young owls were hand-fed with small pieces of food until they were capable of self-feeding, whereupon they joined a creche. Once capable of flight at approximately 35–40 days of age, the owls were transferred to outdoor aviaries ($4 \times 6 \times 3$ m) equipped with perches and hiding areas that facilitated exercise and adaptation to climatic conditions. At this point food was provided once per day in the evening.

Prior to release, all the owls were fully assessed and health checked. The owls were released at the begin-

ning of August in each year of the study as by this time of year they were approximately three months post-fledging and would be independent in the wild (Newton, 1979). On the evening of release they were caught up from the aviaries and placed into cardboard transport boxes ($30 \times 30 \times 45$ cm). Release sites that provided suitable habitat within 20 minutes drive from the rehabilitation centres were chosen, and the owls were transported by vehicle and released from their boxes after dusk (between 21.00 and 23.00). Release habitats varied and included deciduous forest, plantation forest and mixed woodland.

All owls were fitted with tail mounted TW4 radio tags (Biotrack Ltd, Wareham UK) following the method of Kenward (2001). The tags weighed 2.4 g, had a battery life of six months and a maximum range of 6 km. The weight of the tags was less than 1% of the owls' weight which is below the recommended maximum for tags of 5% of the body weight of flying animals (Aldridge and Brigham, 1988). Radio tags were fitted one week before release to allow the owls to become accustomed to them as well as assess the success of the attachment. After release the owls were tracked on foot and by car with a Biotrack SIKA receiver and an ICOM 3000 receiver (Icom America Inc, Washington USA) using three and five element yagi antennae. Positions of the owls were recorded every 24 hours for the first 14 days of the study, and every 48 hrs from day 15 to day 42. This was reduced to once a week after 42 days until the signal was lost, the transmitter detached, or the bird was confirmed dead. Tracking was carried out during the day to identify the roosting positions of the owls. No attempt was made to track them at night. If a bird could not be found at the previously recorded position then a systematic search of the surrounding area was carried out until the bird was found. Efforts to relocate a missing signal continued for one week, after which time radio frequencies of missing birds were scanned opportunistically during the tracking of other birds. Visual confirmation of an owl was made where possible.

Kaplan–Meier (K–M) survivorship curves (Kaplan and Meier, 1958) and median survival estimates were produced for the rehabilitated Tawny Owls released in this study. For comparison, published data from Bennett and Routh (2000) and Leighton *et al*. (2008) were used to produce K–M survivorship curves for 'soft released' rehabilitated juvenile Tawny Owls ($n = 20$). These 'soft released' birds, which were of similar age to our 'hard released' birds, were rehabilitated and released by the RSPCA's Stapley Grange and East Winch wildlife centres using similar methods. Published data from Coles and Petty (1997) were used to produce K–M survivorship curves for wild juvenile Tawny Owls ($n = 22$). The wild birds were located in Kielder Forest, Hexham, UK. All analyses were run using 'R' (version 1.9.1; R Core Development Team, 2004). Cox Proportional Hazards regressions were conducted to test the difference between the three groups.

Table 1 The number of juvenile Tawny Owls released and tracked from each centre in each of the study years

Year	2005	2006	2007
The Hawk Conservancy Trust	10	10	14
RSPCA West Hatch Wildlife Centre	0	12	11

3. RESULTS

Admission dates of juvenile Tawny Owls ranged from February to June and all birds were released in August of their hatching year: 10 birds in 2005; 22 birds in 2006 and 25 birds in 2007. Thirty-four (60%) of the Owls were rehabilitated at the Hawk Conservancy Trust and the remaining 23 (40%) at the RSPCA West Hatch Centre (see Table 1).

Owls were successfully tracked for between three and 160 days (median = 32). Mortality was recorded for 16 (28%) of the owls between five and 77 days after release (median = 32). Cause of death could not be determined in most cases but predation was strongly suspected for four birds. The transmitter was shed by 24 (42%) owls between four and 160 days (median = 27). The transmitter was still attached to the tail feather in 12 cases, the bird having moulted or plucked the feather during preening. The remaining 12 transmitters had become detached from the feather itself. The signal was lost and the fate unknown for 12 (21%) owls between three and 67 days after release (median = 41) despite all efforts to relocate the signal. Tracking was ceased for the final five (9%) birds between eight and 160 days after release (median = 50) due to manpower limitations.

At least 38 owls (67%) survived 20 days after release. As some results were unknown due to shed tags and lost signals, it is possible that survival at 20 days after release was as high as 91%. At least 33 owls (58%) were alive 30 days after release, and a further 17 owls (30%) had unknown outcomes. Table 2 shows percentage survival up to 70 days post release.

Cox Proportional Hazards regressions analysis showed no significant difference in survival of Tawny Owls from the Hawk Conservancy Trust and Tawny Owls from RSPCA West Hatch Wildlife Centre ($z = -0.718$, $P = 0.473$). K–M survivorship curves for all the 'hard release' owls we studied showed that median survival was 77 days (95% confidence inter-

Table 2 The percentage survival of 'hard released' juvenile Tawny Owls for every 10 days post-release up to 70 days. Upper and lower limits were calculated assuming all 'lost' animals either survived or died, respectively

Day	10	20	30	40	50	60	70
Upper limit % survival	93	91	88	79	77	75	75
Lower limit % survival	82	67	58	40	26	16	12

vals were 56.0 to unknown, as an upper estimate was not reached). A median survival estimate for 'soft-released' birds was not found, as too few birds had died for the survivorship curve to cross the 0.50 survivorship level – only five deaths occurred during the monitoring period and 15 were 'lost' and so interpretation is very limited. See Figure 1.

The survivorship curves of the 'soft released' birds and our 'hard released' birds are compared in Figure 1. 'Soft-release' owls look to have a slightly higher survival rate than 'hard-released' birds, but this difference was not significant ($z = -0.314$, $P = 0.75$), which may be the result of the large confidence intervals. Note that sample sizes were small, and so results should be interpreted within this context

Wild birds had a median survival of 80 days after tracking began, with 95% confidence intervals of 54 to unknown (upper estimate for median not reached). Thirteen deaths occurred in this dataset, and nine birds were 'lost'. The survivorship curves of the wild birds and our 'hard released' birds are compared in Figure 2. The curves show very similar survival of the two groups up until 77 days, after which no further birds in the rehabilitated group were found dead or were lost thus accounting for the flattening out of the curve at this point. A Cox Proportional Hazards regression showed no statistical difference in the survival of wild and 'hard released' Tawny Owls ($z = 0.392$, $P = 0.7$).

4. DISCUSSION

This study aimed to investigate the survival of 'hard released' juvenile rehabilitated Tawny Owls to evaluate the welfare outcome of the rehabilitation process and release method. To act as a benchmark, we compared the survival of the owls with that of previously studied wild Tawny Owls to determine if the rehabilitated owls possessed comparative survival skills after release. We also compared survival of the owls with that of previously studied 'soft-release' juvenile Tawny Owls to evaluate the release method and determine the necessity of using a 'soft release' for juvenile Tawny Owls.

The survivorship curve for wild juvenile Tawny Owls (data from Coles and Petty, 1997) showed survivorship to be very similar to the 'hard released' owls (Figure 1). Although we found no significant difference in survival, a critical difference between the two groups is age. Coles and Petty (1997) reported survival time after fledging, at which point their owls

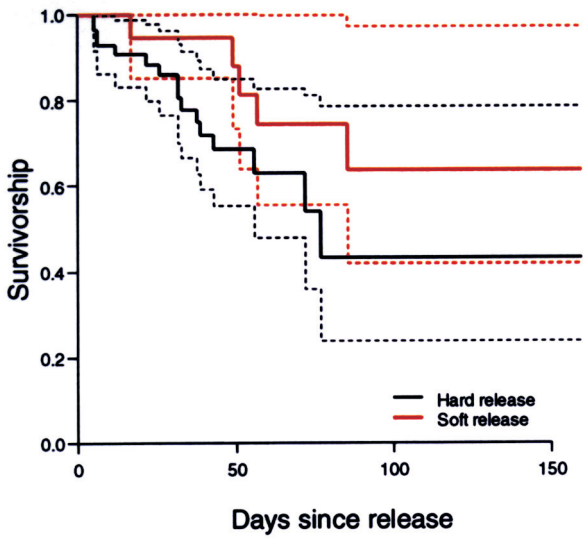

Figure 1 Comparison of the survival of 'hard released' Tawny Owls from this study and 'soft released' juvenile Tawny Owls (Bennett and Routh, 2000; Leighton *et al.*, 2008). Dashed lines are 95% confidence intervals.

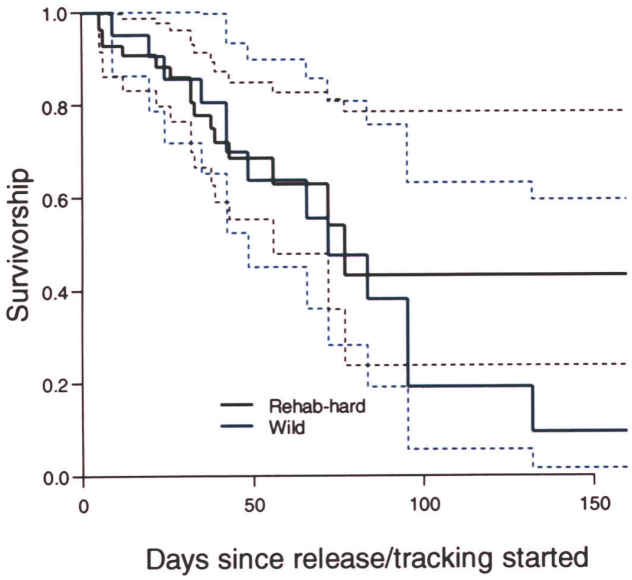

Figure 2 Comparison of the survival of 'hard released' rehabilitated juvenile Tawny Owls (this paper) with wild juvenile Tawny Owls (Coles and Petty, 1997). Dashed lines are 95% confidence intervals.

were an average of 32 days old. We report survival of rehabilitated juveniles from the point of release, at which time the owls are significantly older at 60 to 150 days old. We do not consider that this age difference negates the value of wild bird data as a benchmark for the purpose of assessing success in the rehabilitation process. For example, birds in both groups are likely to be equally naïve to their natural habitat at the point of release/fledging. We found that survival of our 'hard released' rehabilitated tawny owls during the first weeks of release is very similar to survival of wild tawny owls after fledgling. Another potential difference between the two groups is that Coles and Petty (1997) conducted their study at a low point in the vole cycle whereas we do not have vole cycle data for our study. However no other radio-tracking studies have been conducted in the UK on wild juvenile Tawny Owls so we feel that this potentially significant difference, is an unavoidable shortcoming and one that should be borne in mind for future studies.

To evaluate further the release method, we compared survival of our owls with that of previously studied 'soft-release' juvenile Tawny Owls. Survivorship analysis showed that our 'hard released' Tawny Owls had a median survival of 77 days. Survival of the soft released juvenile Tawny Owls studied by Bennett and Routh (2000) and Leighton *et al*. (2008) did not differ significantly, but no median survival could be calculated because sample sizes were small and too few owls had died. Although conclusions are somewhat limited due to the sample sizes involved, these results suggest that 'hard releases' for rehabilitated juvenile Tawny Owls provide an equivalent survival outcome and that 'soft releases' are unnecessary.

An often used benchmark in previous studies to determine success of released birds of prey is survival at 42 days post release, by which time a raptor is assumed to be hunting independently (Duke *et al*., 1981; Martell *et al*., 1991). Leighton *et al*. (2008) showed survival of 'soft released' birds at 42 days to be at least 37.5% (with 43.5% unknown outcomes). Our study on 'hard released' birds found survival at 42 days to be at least 38.6% (with 40.4% unknown outcomes). By including 'lost' birds in survival estimates, up to the point of loss, (using K–M curves), the probability of survival at 42 days is 0.81 (95%CI 0.65–0.99) for wild birds compared to 0.74 (95%CI 0.56–0.99) for 'soft released' and 0.72 (95%CI 0.59–0.87) for 'hard released' birds.

This said, we feel that using 42 days as a benchmark survival period for small raptors is unnecessarily long. The 42 day benchmark was first used in a study by Duke *et al*. (1981) and is derived from the starvation period of two to three weeks for Red-tailed Buzzards (*Buteo jamaicensis*). However, smaller raptors would succumb to starvation more rapidly (Duke *et al*., 1981) and Tawny Owls will die of starvation within eight to 14 days (Murn, unpublished data). We thus consider that a benchmark more suited to determining whether Tawny Owls are feeding independently is 30 days. Using this benchmark, survival for birds known to be living or dead was at least 57.9% for our 'hard released' birds, 60.0% for 'soft released' birds (Bennett and Routh, 2000; Leighton *et al*., 2008) and 81.8% for wild Tawny Owls (Coles and Petty, 1997). By including 'lost' birds in survival estimates (using K–M curves), the probability of survival at 30 days is 0.86 (95%CI 0.77–0.96) for 'hard released', 0.74 (95%CI 0.56–1.00) for 'soft released' and 0.86 (95%CI 0.72–1.00) for wild birds. These studies on wild owls include survival throughout the dependency period (2.5–3 months, Newton, 1979) whereas studies on rehabilitated juvenile owls commence on release, which is normally conducted at the end of the dependency period.

While single values are useful for describing survival, statistically comparing survival curves provides far more information. By using this technique, our results suggest that employing costly and time-consuming 'soft release' techniques may be unnecessary for juvenile Tawny Owls, as their survival is not significantly reduced using 'hard release' methods.

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