The Old School, Brewhouse Hill, Wheathampstead,
Hertfordshire AL4 8AN, UK

Animal Welfare 2011, 20: 523-534
ISSN 0962-7286

Factors affecting the likelihood of release of injured and orphaned woodpigeons (*Columba palumbus*)

A Kelly*†, C Halstead‡, D Hunter§, K Leighton#, A Grogan† and M Harris‡

† RSPCA, Wildlife Department, Wilberforce Way, Southwater, Horsham, West Sussex RH13 9RS, UK
‡ Harper Adams University College, Newport, Shropshire TF10 8NB, UK
§ RSPCA Stapeley Grange Wildlife Centre, London Rd, Stapeley, Nantwich, Cheshire CW5 7JW, UK
# RSPCA East Winch Wildlife Centre, East Winch, Norfolk PE32 1NR, UK
* Contact for correspondence and requests for reprints: andkelly@rspca.org.uk

Abstract

*Very little is known about the fate of the large numbers of injured and orphaned wild animals taken to wildlife rehabilitation centres in the UK each year. We reviewed the reasons for admission and outcomes for 2,653 woodpigeons (*Columba palumbus*), 68% of which were juveniles, brought to an RSPCA wildlife rehabilitation centre in Cheshire, UK over a five-year period (2005–2009). Reasons for admission varied with the most common reason for adults and juveniles being 'injury (cause uncertain)' and 'orphan', respectively. Twenty-one percent of adults and 16% of juveniles had been attacked by cats. Sixty-five percent of adults and 37% of juveniles were euthanased on admission or within the first 48 h to prevent further suffering. Only 14% of adults and 31% of juveniles were released back into the wild. The remainder were either euthanased or died despite treatment more than 48 h after admission. Body condition on admission was not a good predictor of the likelihood of release, but age, weight on admission and severity of symptoms were significant factors. A reduction in the median number of days in care for those birds euthanased more than 48 h after being admitted was recorded for 2007 to 2009, possibly due to the introduction of radiography for all birds on admission. Leg-band recovery data for 15 birds revealed post-release survival ranging from 21–2,545 days (median = 231 days) compared to 1–2,898 days (median = 295) for non-rehabilitated birds.*

Keywords: *animal welfare,* Columba palumbus*, post-release survival, RSPCA, wildlife rehabilitation, woodpigeon*

Introduction

Wildlife rehabilitation, ie "the managed process whereby a displaced, sick, injured or orphaned animal regains the health and skills it requires to function normally and live self-sufficiently" (IWRC 2010), is a large and common international practice which aims to return sick, injured or orphaned wild animals back to the wild. In Britain, there are thought to be approximately 650 wildlife rehabilitation centres (A Grogan, personal communication 2008) and it has been estimated that between 30,000–40,000 wildlife casualties are taken to wildlife rehabilitation centres each year (Molony *et al* 2007). However, as no accurate data are collated, this number could be much greater. Such large numbers of wild animals being taken into care annually raises significant welfare concerns since individuals may suffer whilst in captivity and undergoing treatment and very little is known about the fate of these animals either during the rehabilitation process or after release. In addition, wildlife rehabilitation has been criticised as being a waste of time and resources (Sharp 1996; Goldsworthy 2000) and ethically dubious under some circumstances (Kirkwood & Sainsbury 1996). It is therefore vital for wildlife rehabilitators to regularly review their protocols and use data generated over the years to better inform their admissions policy and to enable them to make swift decisions on the future of admitted casualties. It is also essential that rehabilitators demonstrate that the welfare of the animals they are caring for is not compromised by the processes involved.

Many wildlife rehabilitators equate release with success (Sharp 1996) and although some studies have focused on post-release survival of rehabilitated wildlife including raptors (Martell *et al* 1991; Fajardo *et al* 2000; Leighton *et al* 2008), oiled seabirds (Sharp 1996; Werner *et al* 1997) and mammals such as red foxes (*Vulpes vulpes*) (Robertson & Harris 1995), Eurasian hedgehogs (*Erinaceus europaeus*) (Morris 1998), pipistrelle bats (*Pipistrellus* spp) (Kelly *et al* 2008) and polecats (*Mustela putorius*) (Kelly *et al* 2010) there is a paucity of information on what happens to injured or orphaned wildlife whilst in care. In addition to being injured, wildlife casualties are subsequently exposed to the potential stress of treatment and captivity. Given the large number of animals involved, wildlife rehabilitation could constitute a significant animal welfare issue. Few studies have examined survival rates of wildlife casualties whilst in care, despite overall release rates of less than 45% (Kirkwood 2003) and which vary considerably between species (17 to 80%; Garland *et al* 2003).

Whilst in care, mortality of wildlife casualties may be a result of the severity of their injuries or nature of their illness, or because the animals do not respond to the treatment given. Molony *et al* (2007) found that the most important predictor of the likelihood of release for eight species commonly admitted to wildlife rehabilitation centres was the severity of symptoms. It is therefore very important for wildlife carers to recognise, as soon as possible, those individuals for which the prognosis is poor and euthanase the animal to prevent further suffering.

In addition to severity of injury and illness, there may be other factors that will allow rehabilitators to make informed judgements on the future of casualties presented to them. It is well known that age and body condition can affect individual survival in the wild and it could be expected that age and body condition may affect the likelihood of survival of wildlife casualties whilst in care. Molony *et al* (2007) found that age and weight on admission did not affect the outcome for the eight species they studied. Kelly and Bland (2006) also found that, although the severity of injury was the main predictive factor for the likelihood of release for sparrowhawks (*Accipiter nisus*) there was a significant interaction between age and sex in that species, with adult females being more likely to be released than adult males, but no difference in the likelihood of release for male or female juveniles. The period of captivity may also affect the outcome for individuals. Whilst in captivity the effects of novel stimuli and handling by humans will cause stress to the animals (eg Boissy 1995; Wingfield *et al* 1997). It is well known that chronic stress can have negative effects on the immune system (Carlstead 1996), which may affect the likelihood of successful rehabilitation. However, the effects of chronic stress are seldom taken into consideration in captive-bred animals released to the wild in re-introduction projects (Teixeira *et al* 2007) and are rarely, if ever, considered by wildlife rehabilitators.

The woodpigeon (*Columba palumbus*) is an abundant resident breeder and winter visitor in the UK (Murton 1965). At 41 cm and with a wingspan of 78 cm, the woodpigeon is Europe's largest pigeon (Snow & Perrins 1998) and with over 2.5 million territories (Birdlife International 2004) it is one of Britain's most common species. Population has shown a rapid increase since the 1970s, at least in part due to the spread of intensive arable cultivation, particularly oilseed rape (*Brassica napus*), which has been demonstrated to promote over-winter survival (Gibbons *et al* 1993; Inglis *et al* 1997). The combined Common Bird Census/Breeding Bird Survey (CBC/BBS) has estimated the population to have grown by 146% between 1967 and 2006 (Birdlife International 2004). Due to their abundance, and since they are commonly found nesting in towns and villages (Slater 2001), woodpigeons are likely to come into contact with humans regularly and injured or orphaned birds are commonly found by members of the public and brought to wildlife rehabilitation centres in the UK. Between 2005 and 2009, the RSPCA admitted over 6,000 to their four wildlife rehabilitation centres (A Kelly, personal observation 2009). With the population of woodpigeons increasing rapidly, it is likely that numbers taken to wildlife rehabilitation centres will also increase in direct proportion. The number of individual birds involved raises significant concern for the welfare of those taken into care. To-date, no studies have considered the potential welfare issues involved in the large numbers of woodpigeons being cared for in rehabilitation centres.

Here, we retrospectively reviewed the reasons for admission and outcomes for woodpigeons admitted to the RSPCA Stapeley Grange Wildlife Centre (SGWC) in Cheshire, UK over a five-year period (January 2005–December 2009). We examined factors that may be used to predict the likelihood of release, including year, season, reason for admission, age, body condition on arrival, weight on arrival, clinical diagnosis, body condition, severity of symptoms and the number of days in care. Specifically, as body condition is known to affect survival in wild birds, we tested the hypothesis that body condition on arrival can be used to predict the likelihood of release for both adult and juvenile birds. We also looked for evidence that triage has improved over the five-year period by examining the percentage of woodpigeons euthanased on admission or within the first 48 h following admission. We also examined the length of time in care for those birds that died or were euthanased in care more than 48 h after admission, since these are the individuals presenting the greatest welfare concern. We compared the median number of days spent in captivity for these birds and for those subsequently released back to the wild to identify improvements in the rehabilitation process over the five-year period. Finally, we looked at the limited information available on post-release survival of rehabilitated woodpigeons using leg-band recovery data of rehabilitated and non-rehabilitated birds. We considered post-release survival of more than eight weeks to indicate that the birds were capable of surviving independently, as it is likely that any birds unable to forage effectively would starve within this period.

Materials and methods

Admission protocol

Following admission, all woodpigeons were examined by a veterinary surgeon or triaged by an experienced wildlife assistant who referred those requiring further investigation to a veterinary surgeon. The decision on whether to euthanase on admission or admit the bird and give appropriate treatment was taken in accordance with the RSPCA-written protocol for pigeons (RSPCA, unpublished 2005–2009). Those individuals considered unsuitable for rehabilitation due to the nature of their injuries (eg *in extremis*, compound fractures, old necrotic wounds) or found to be suffering from trichomoniasis (or canker), a disease caused by the

https://doi.org/10.1017/S096272860000316X Published online by Cambridge University Press

protozoan *Trichomonas gallinae*, were euthanased on admission. In all cases, euthanasia was induced by administering 1 ml of Pentobarbitone Sodium (20%) (Pentoject, Animalcare Ltd, York, UK) intra-abdominally, using a 23 gauge needle injected just behind the most caudal aspect of the sternum and directed craniodorsally. The date of admission (month) and age (adult or juvenile) were recorded for all birds. Between 2005 and 2006, birds were X-rayed at the discretion of the veterinary surgeon. From 2007, all birds were X-rayed on admission to detect fractures or osteodystrophy (metabolic bone disease [MBD]), a common problem associated with the pigeon family (Cousquer *et al* 2007) caused by vitamin D deficiency. This leads to poor calcium metabolism, with birds suffering from 'bendy bones' and an increased susceptibility to fractures.

Reasons for admission and outcomes

We retrospectively examined the clinical record cards of woodpigeons admitted to Stapeley Grange Wildlife Centre over a five-year period, from 01/01/2005 to 31/12/2009. The reason for admission was recorded as: Grounded (no obvious injuries); Injury (cause uncertain); Collision (mainly vehicles or windows); Attacked by other animal (cat, dog, hawk); Trapped (chimney or other); Disease (mainly trichomoniasis); Other (shot, fishing line, not recorded). A further category of Orphan was added for juveniles. These were defined as those birds that were not capable of independent survival (ie not fledged). Outcomes were recorded as: euthanased on admission (EA), euthanased within 48 h (E < 48); euthanased after 48 h (E > 48); died in care within 48 h (D < 48); died in care after 48 h (D > 48); released (R).

Body condition, clinical diagnosis and severity of symptoms

Body condition of adults and juveniles was measured by assessing the pectoral muscle coverage on the keel. Three categories were recorded: emaciated (keel very prominent); thin (keel prominent) and moderate/good (keel normal, good muscle coverage). Clinical diagnosis was categorised as: NAD (No abnormality detected); Central Nervous System (CNS) damage; Gastro-intestinal (GI) tract infection (trichomoniasis in all cases); Muscular/skeletal damage (included open and closed fractures and serious trauma); Integument (minor or deep puncture wounds and/or feather loss); Respiratory system damage; Sensory system damage (eg eye damage) and/or Systemic (metabolic bone disease [MBD]). Severity of symptoms was categorised as: NAD (No abnormality detected); Minor (minor tissue injuries, minor feather loss) or Major (fractures, CNS damage, disease, MBD, major feather loss).

Release criteria

Adult birds were released once they were considered fit and able to fly. Juvenile birds were moved to an external aviary (10 × 5 × 2.5 m; length × width × height) once they had reached a bodyweight of 300 g where they stayed for 3 to 4 weeks until they had attained strong flight, had good body condition and good feather condition.

Table 1 Variables collected for use in binary logistic regression models.

Variable	Variable type	Description
Outcome	Categorical	Released = 1, Died in care = 0
Year	Categorical	2005–2009
Month	Categorical	January–December
Age	Categorical	Adult or Juvenile
Weight	Continuous	Weight on admission (g)
Reason	Categorical	Reason for admission
Body condition	Categorical	Emaciated, thin, good
Clinical diagnosis	Categorical	NAD, CNS, MS, Int, Resp, GI, SS
Symptom severity	Categorical	NAD, Minor, Major

Reason for admission included: Grounded (no obvious injuries); Injury (cause uncertain); Collision (mainly cars or windows); Attacked by other animal (cat, dog, hawk); Trapped (chimney or other); Disease (mostly trichomoniasis); Other (shot, not recorded); NAD = no abnormality detected; CNS = central nervous system; MS = muscular/skeletal; Int = integument; Resp = respiratory system; GI = gastrointestinal; SS = sensory system.

Post-release survival

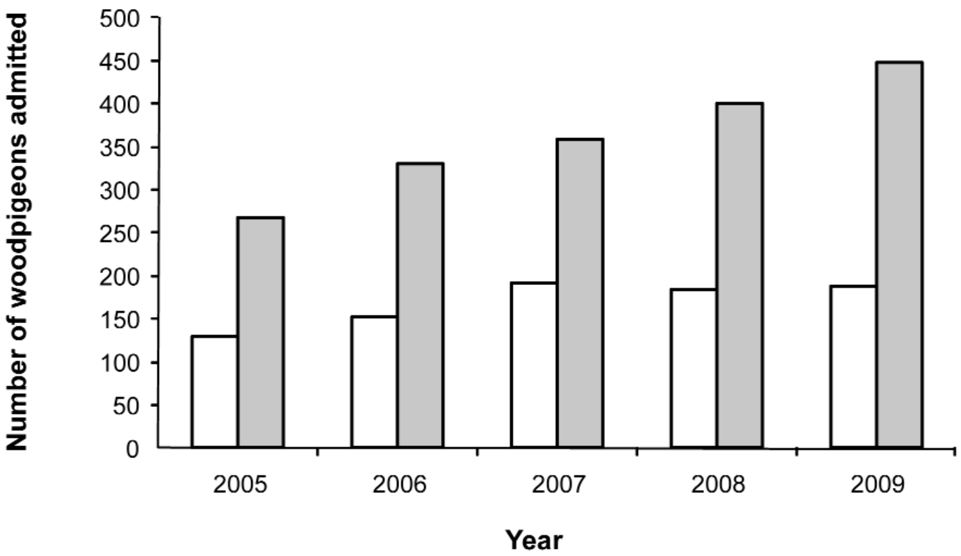
Between 2000 and 2008, 1,086 rehabilitated woodpigeons were fitted with leg bands at three RSPCA wildlife rehabilitation centres, using standard methodology and equipment under licence from the British Trust for Ornithology (BTO). The leg bands contained the contact details of the BTO, which informs the band fitters on receipt of a returned band. We compared the median number of days between ringing and recovery for rehabilitated juvenile woodpigeons with *pulli* (young bird in the downy stage) ringed on the nest.

Statistical analysis

Statistical analyses were carried out using PASW 18.0 (formerly SPSS). Binary logistic regression was used to identify factors that affected the likelihood of release, with the dependent variable being 'released (= 1) or died in care (= 0)'. The variables available for use in binary logistic models are shown in Table 1. Each variable was tested separately against the dependent variable and excluded from the model if $P > 0.05$. Co-linearity between variables was tested using Spearman's rank order correlation (Field 2005). The goodness of fit for the final model was tested using Hosmer-Lemeshow, Cox and Snell and Nagelkerke statistics. Hosmer-Lemeshow tests for continuous variable, while Cox and Snell and Nagelkerke statistics are pseudo R^2 statistics used in logistic regression to test categorical variables (Field 2005). Effect sizes are expressed as odds ratios [P(released)/P(died or euthanased in care > 48 h)]. Odds ratios > 1 indicated that birds were more likely to be released than die in care. Casualties that were euthanased on admission or within 48 h were excluded from the data to avoid biasing the data towards those animals with a poor

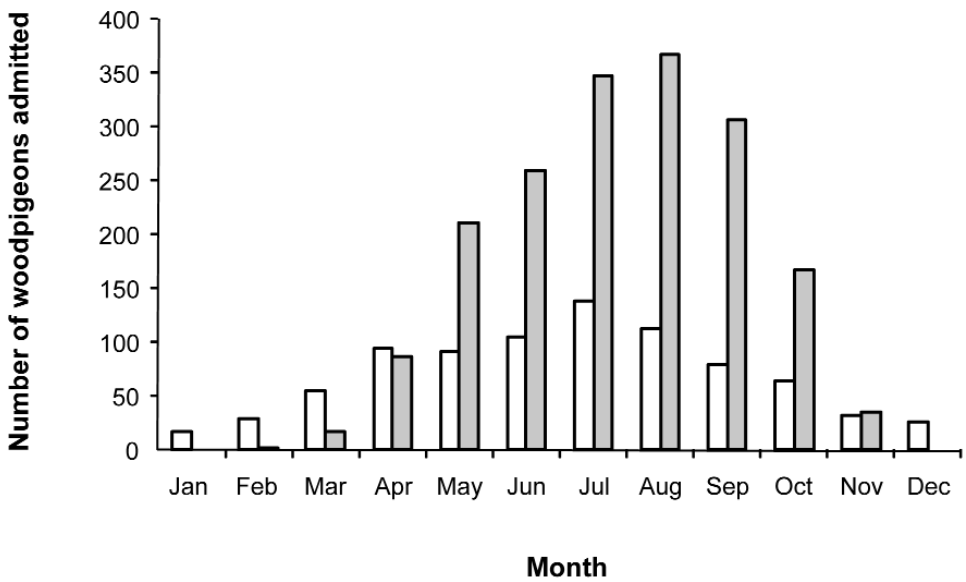
https://doi.org/10.1017/S096272860000316X Published online by Cambridge University Press

Figure 1



The number of adult (white bars) and juvenile (grey bars) woodpigeons admitted to Stapeley Grange Wildlife Centre between 2005 and 2009.

Figure 2



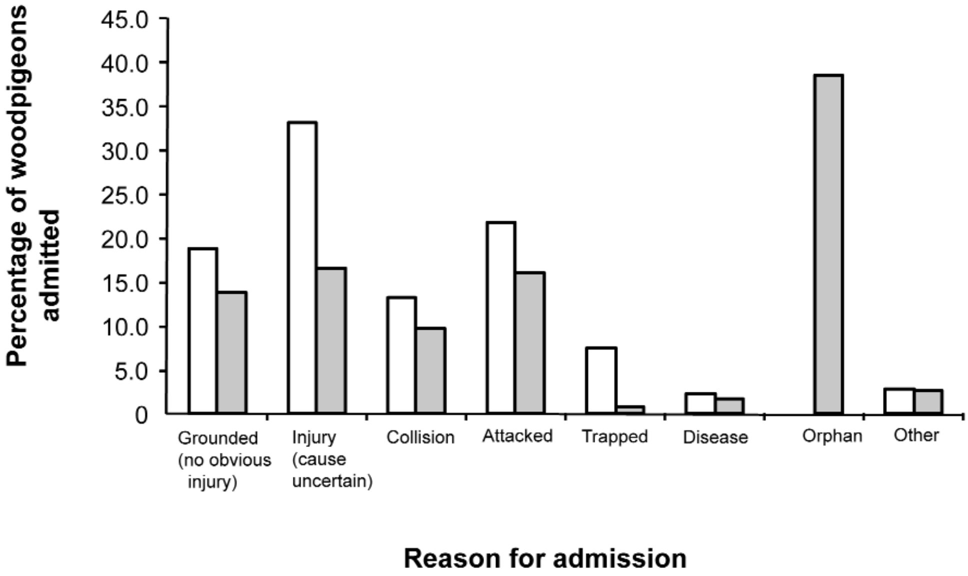
Numbers of adult (white bars) and juvenile (grey bars) woodpigeons admitted to Stapeley Grange Wildlife Centre monthly between 2005 and 2009.

prognosis (Molony *et al* 2007). The number of days in care for birds euthanased after 48 h and for those birds subsequently released in each year was compared using non-parametric Kruskal-Wallis tests. *Post hoc* Mann-Whitney *U* tests were used to compare differences between groups (Field 2005). As multiple Mann-Whitney *U* tests were used, a Bonferroni correction was applied (0.05/number of tests), (Field 2005). The median number of days between ringing and recovery for rehabilitated and non-rehabilitated juvenile woodpigeons was compared using a Mann-Whitney *U* test.

Results

Between January 2005 and December 2009, 2,653 woodpigeons, mean (± SD) per year = 531 (± 93), were admitted to Stapeley Grange, of which 68% (n = 1,805) were recorded as juveniles. The numbers admitted in each year ranged from 130–192 and 268–447 for adults and juveniles, respectively, showing an increasing trend in the numbers admitted, particularly for juveniles (Figure 1). Of the 1,805 juveniles admitted, 693 (38%) were recorded as orphans. Body condition was recorded for 1,423 birds

Figure 3



The percentage of adult (white bars) and juvenile (grey bars) woodpigeons admitted to Stapeley Grange Wildlife Centre for different reasons between 2005 and 2009.

(476 adults and 947 juveniles). Figure 2 shows the numbers of adults and juveniles admitted to Stapeley Grange in each month between 2005 and 2009.

Reasons for admission

The percentages of adult and juvenile woodpigeons admitted for different reasons are shown in Figure 3. The most common recorded reason for admission for adults was 'Injury (cause uncertain)' followed by 'Attacked by other animal', 'Grounded (no obvious reason)' and 'Collision'. Domestic cats (*Felis catus domesticus*) were responsible for 92% of 'Attacked' adults. Household chimneys accounted for 95% of 'Trapped' adults. The most common reason for admission for juveniles was 'Orphan' followed by 'Attacked' and 'Injury (cause uncertain)', both of which accounted for 16%, and 'Grounded (no obvious reason)'. Body condition for 'Orphans' was variable but otherwise they were uninjured and not suffering from infectious disease.

Outcomes

Figure 4 shows the outcomes for all adult and juvenile woodpigeons admitted between 2005 and 2009. Of the 2,653 woodpigeons admitted, only 14% of adults and 31% of juveniles were released back into the wild. Juveniles were significantly more likely to be released than adults ($\chi^2_1 = 86.68$, $P < 0.001$). Sixty-five percent of adults and 37% of juveniles were euthanased either on admission or within 48 h, due to the severity of their symptoms and to prevent further suffering (Figure 4). Twenty percent of adults and 30% of juveniles died or were euthanased more than 48 h after admission. Between 2005 and 2009, the percentage of adults and juveniles euthanased on admission or within 48 h of admission, increased by 21 and 13%, respectively (Figure 5). For released juveniles, release weights ranged from 306 to 484 g (median = 378 g, n = 106).

Body condition, clinical diagnosis and severity of symptoms

Body condition and clinical diagnosis were recorded for 1,423 birds (476 adults and 976 juveniles). Of these, 688 were either released or euthanased/died more than 48 h after admission. However, only 635 had weight on admission recorded and so only these individuals were included in the final model.

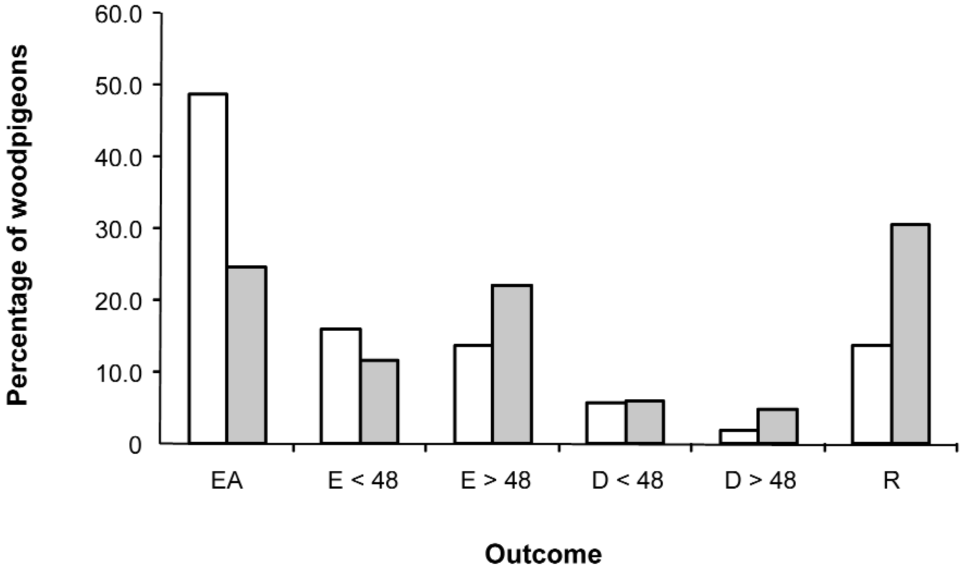
Binary logistic regression

Year, month of admission, reason for admission and body condition were not significant factors in determining the outcome for individual birds and were subsequently excluded from the final model. Age, weight on admission and severity of symptoms were significant factors in determining the likelihood of release (Table 2). The model correctly predicted the outcome on 82.5% of occasions and explained 61.8% of the variation (Table 3).

Higher weight on admission resulted in a slightly greater likelihood of release for juveniles. Juveniles were, on average, over three times more likely to be released than adults. When compared to birds with no abnormalities detected (NAD), there was no significant difference in the likelihood of release for those with minor symptoms, but those with major symptoms were significantly less likely to be released (Table 2).

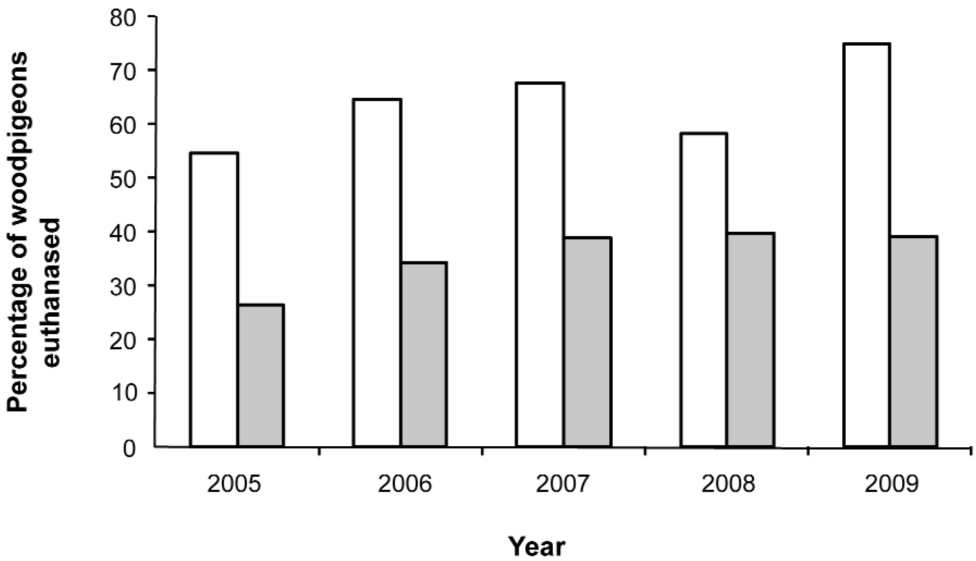
https://doi.org/10.1017/S096272860000316X Published online by Cambridge University Press

Figure 4



Outcomes for adult (white bars) and juvenile (grey bars) woodpigeons admitted to Stapeley Grange Wildlife Centre between 2005 and 2009. EA = euthanased on admission; E < 48 = euthanased within 48 h of admission; E > 48 = euthanased more than 48 h after admission; D < 48 = died in care within 48 h despite treatment; D > 48 = died in care more than 48 h after admission, despite treatment; R = released.

Figure 5



The percentage of adult (white bars) and juvenile (grey bars) woodpigeons euthanased on admission or within 48 h of admission to Stapeley Grange Wildlife Centre between 2005 and 2009.

We tested for co-linearity of the factors in the final model and found a significant correlation between age and weight on admission (Spearman rank correlation $r_s = -0.552$, $P < 0.01$), age and body condition ($r_s = -0.089$, $P = 0.025$) and age and severity of symptoms ($r_s = -0.079$, $P = 0.047$). There was no significant co-linearity between severity of symptoms and body condition ($r_s = 0.068$, $P > 0.05$). Age, weight on admission and severity of symptoms were retained in the final model.

Days in care

The median number of days in care for those birds euthanased after 48 h and for those birds subsequently released back to the wild are shown in Figures 6 and 7,

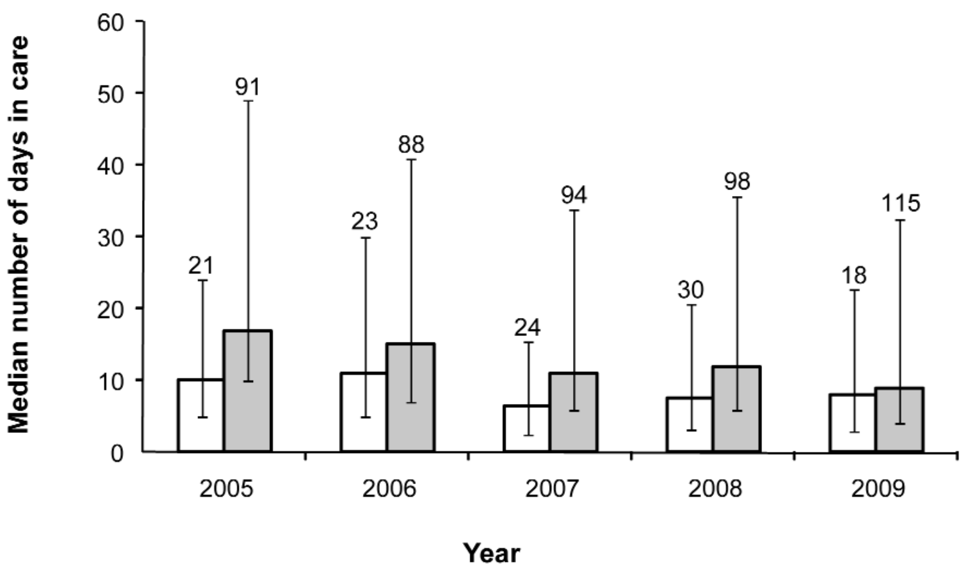
Table 2 Final binary logistic model results. Odds ratios > 1 indicated that birds were more likely to be released than die in care.

Variable	B	SE	Wald	df	*P*-value	Odds ratio	CI (95%) for EXP (B)
Weight (on admission)	0.009	0.002	33.191	1	< 0.001	1.009	1.006–1.013
Age (juvenile)	1.126	0.333	11.444	1	< 0.001	3.082	1.605–5.916
Symptoms (NAD)	–	–	204.360	2	< 0.001	–	–
Symptoms (Minor)	–0.14	0.489	0.001	1	0.977	0.986	0.378–2.571
Symptoms (Major)	–3.53	0.269	172.492	1	< 0.001	0.029	0.017–0.050
Constant	–1.572	0.640	6.029	1	0.014	0.208	–

Table 3 Goodness of fit of binary logistic model.

N	% released	Homer-Lemeshow	Cox & Snell	Nagelkerke	% variation explained by the model
635	49.6	χ^2_8 = 5.656, *P* = 0.686	0.411	0.548	61.8

Figure 6



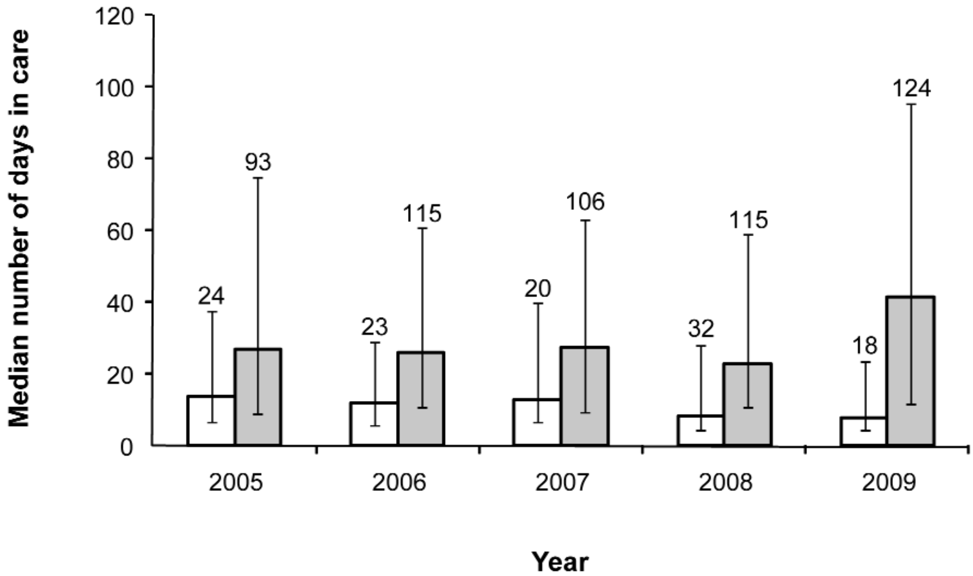
Median number of days in care with sample sizes for adult (white bars) and juvenile (grey bars) woodpigeons euthanased in care more than 48 h after admission between 2005 and 2009. Error bars represent 25 and 75% interquartile range. The number of birds is given above the error bars.

respectively. The number of days in care for adults and juveniles that were euthanased more than 48 h after admission ranged from 2–84 days (n = 131) and 2–214 days (n = 486) for adults and juveniles, respectively. There was no significant difference between years for adults (H = 5.5, df = 4, ns). However, the number of days in care for juveniles euthanased after more than 48 h differed significantly between years (H = 11.7, df = 4, P = 0.018). *Post hoc* Mann-Whitney U tests (Bonferroni-adjusted alpha level of 0.0071 [0.05/7]) indicated that the median number of days in care did not differ significantly between 2009 and 2008 (U = 5,120, df = 1, P = 0.254), 2007 (U = 5.73, df =1, P = 0.941), 2006 (U = 4097.5, df = 1, P = 0.02) or 2005 (U = 4,164, df = 1, P = 0.012). There was no significant difference between 2008 and 2005, 2006 or 2007 (all P > 0.05).

The number of days in care for adults and juveniles subsequently released back to the wild ranged from 1–61 days (n = 116) and 1–161 days (n = 553), respectively. The median numbers of days in care for birds that were released are shown in Figure 7. There was no significant difference between years for adults (H = 4.27, df = 4, P = 0.371, ns). However, the number of days in care for juveniles that were subsequently released differed significantly between years (H = 56.2, df = 4, P < 0.001). *Post hoc* Mann-Whitney U

https://doi.org/10.1017/S096272860000316X Published online by Cambridge University Press

Figure 7



Median number of days in care and sample sizes for adult (white bars) and juvenile (grey bars) woodpigeons released following rehabilitation between 2005 and 2009. Error bars represent 25 and 75% interquartile range. The number of birds is given above error bars.

Table 4 Band-return data for 15 woodpigeons banded and released at three RSPCA wildlife rehabilitation centres between 2000 and 2008 and subsequently recovered dead.

Band number	Age	Centre	Date released	Date recovered	Days
FP41357	Juvenile	WH	13/11/2000	01/02/2001	80
FP44860	Juvenile	EW	31/10/2001	01/12/2001	31
FP51934	Juvenile	WH	26/11/2001	17/12/2001	21
FP44876	Juvenile	EW	22/03/2002	10/03/2009	2,545
FP66139	Juvenile	WH	06/11/2003	05/07/2008	1,703
FP63773	Juvenile	EW	23/07/2004	03/07/2006	710
FP63774	Juvenile	EW	21/08/2004	19/09/2008	1,490
FP83324	Juvenile	EW	08/10/2004	14/11/2004	37
FP85529	Juvenile	WH	29/11/2005	28/01/2006	60
FP85600	Juvenile	WH	03/07/2006	24/07/2008	752
FP85645	Adult	WH	11/11/2006	15/08/2008	643
FP92529	Juvenile	EW	16/01/2007	18/01/2007	2
FP84760	Juvenile	SG	29/06/2007	20/03/2008	265
FH05289	Juvenile	WH	26/10/2007	13/06/2008	231
FH17327	Juvenile	EW	22/10/2008	31/01/2009	101

WH = West Hatch, Somerset; EW = East Winch, Norfolk; SG = Stapeley Grange, Cheshire.

tests showed that the median number of days in care in 2009 was significantly greater than all four previous years (all $P < 0.001$). A Bonferroni correction was applied with effects reported at a 0.0125 level of significance.

Post-release survival

Between 2000 and 2008, 15 band recoveries (1.4% of those ringed) were notified by the BTO. All, except one adult, were for juvenile birds banded prior to release. Recovery times ranged from 2–2,545 days (median = 231 days), (see Table 4). All were found freshly dead with the exception of FP84760, which was recorded as 'long dead'. Removing this bird and the adult that only survived for two days from the data, post-release survival for the remaining 13 juveniles ranged from 21–2,545 days (median = 231 days), with 10 (76.9%) surviving for at least eight weeks. Ring returns for pulli ringed on the nest showed post-release survival ranging from 1 to 2,898 days (median = 295, n = 68, recovery rate = 2.7%), with 85.3% surviving for more than eight weeks. The median number of days between ringing and recovery did not differ significantly between rehabilitated birds and those ringed on the nest ($U = 439$, df = 1, $P > 0.05$).

Discussion

Retrospective analyses of clinical record cards depend on the accuracy of the data recorded. Inter-observer effects and observer drift could not be measured, and over the five-year period covered, clinical record cards were completed by many individuals with varying degrees of experience. It should be noted therefore that some cards might have contained omissions and/or inaccuracies, although all staff and volunteers were instructed on data recording. For example, although all woodpigeons admitted had their age recorded (adult or juvenile) there was some overlap in the weight range for the two age groups. Although it is unlikely that younger juveniles would have been incorrectly identified as adults, larger juveniles that had recently undergone their first moult may have been recorded as adults due to their plumage. Weight on admission was only recorded for 630 adults (74%) and 1,497 juveniles (83%). Body condition was recorded for 54% of admissions (57% of adults and 53% juveniles). Therefore, data may have been biased towards those birds thought to be in the poorest condition and despite the categories (emaciated, thin, moderate/good) being clearly defined a level of subjectivity due to inter-observer differences must be assumed. Only 635 admissions (24%) had all the variables listed in Table 1 recorded. In addition, information that could have proved useful (eg sex) were not recorded. Woodpigeons do not demonstrate obvious sexual dimorphism and so this information could not be collected easily. Despite the limitations of retrospective analyses, we believe the sample size to be sufficient to control for any biases that could potentially have occurred.

Over the five-year period, 2,653 woodpigeons were admitted, with 68% being recorded as juveniles. We predicted that age and body condition on admission would be significant factors in determining the likelihood of release. Juveniles may be more challenging to rehabilitate than adults as they have not yet gained the skills required to survive in the wild. However, we found that juveniles were more likely to be released than adults. Only 14% of adults were released compared to 31% of juveniles. One reason for this is that more adult woodpigeons were admitted with traumatic injuries for which the prognosis was poor. For juveniles, 38.6% were orphans with no obvious injuries or disease. In addition, adults appear to be more stressed in captivity (judging by their behaviour) than juveniles which may affect their likelihood of successful rehabilitation (A Kelly, personal observation 2010).

It is well known that body condition is an important factor in determining survival of birds (eg Ringsby *et al* 1998; Naef-Daenzer *et al* 2001). We measured body condition by assessing the muscle mass on the keel and recorded the bodyweight on admission. We predicted that body condition on admission would be a significant factor in determining the likelihood of release. However, we found that body condition was not a good predictor of the outcome for either adults or juveniles. Weight on admission was a significant factor in determining the likelihood of release for woodpigeons. However, Molony *et al* (2007) found that weight on admission was not a good predictor of the outcome for eight species of rehabilitated wildlife, including four species of mammal and four species of birds. Kelly and Bland (2006) found that age had no effect on the likelihood of release of rehabilitated sparrowhawks, but found a significant relationship between age and sex. Adult females were more likely to be released than adult males, again possibly related to stress in captivity.

Perhaps not surprisingly, severity of symptoms was an important factor in predicting the likelihood of release: birds with 'major' symptoms were significantly more likely to be euthanased or die whilst in care. Molony *et al* (2007) also found that severity of symptoms was the most important factor in determining the outcome for eight species admitted to four wildlife rehabilitation centres even after excluding casualties that died within the first 48 h of admission. Whilst it may be intuitive that severity of symptoms will determine the outcome for injured wild animals, many wildlife rehabilitators will attempt to treat all animals presented to them, despite there being little or no chance of successful rehabilitation. Euthanasia should be the preferred option if the prognosis is poor and the animal is likely to suffer whilst undergoing treatment. It is important that wildlife rehabilitators collect appropriate and accurate data that will allow them to review and improve their protocols. In this study, we looked for evidence of improvements in care and postulated that the percentage of birds euthanased on admission or within the first 48 h would increase over the five-year period, due to improved triage. The percentage of adults and juveniles euthanased on admission or within the first 48 h increased from 54.6 to 75% (+ 20.4%) and 26.5 to 39.1% (+ 12.6%), respectively, over the period of our study. This indicates that triage has improved over the five-year period and those birds unlikely to survive to the release stage have been identified within an acceptable period. Currently, few rehabilitators have written protocols (A Grogan, personal observation 2010), many have variable euthanasia policies and triage is often speculative and based on the personal experience of the rehabilitator.

We predicted that the introduction of X-ray examination as standard in 2007 for all woodpigeons would improve triage and lead to an increase in the percentage of birds euthanased in the first 48 h and a decrease in the median number of days in care for those birds that died or were euthanased more than 48 h after admission.

Whilst euthanasia did indeed increase following this improvement in triage, there was a stepwise increase in each year so we cannot be sure that X-ray examination contributed to this. Anecdotally, there were individual birds identified by X-ray on admission as having metabolic bone disease on

https://doi.org/10.1017/S096272860000316X Published online by Cambridge University Press

admission following X-ray which may not have been diagnosed in previous years. These birds would likely have failed to thrive and would have been euthanased days to weeks after admission (A Kelly, personal observation 2009).

A reduction in the median number of days in care for those birds euthanased more than 48 h after admission was observed for 2007 to 2009, compared to 2005–2006 for both adults and juveniles (Figure 6). However, it is unclear whether this was a result of birds being X-rayed.

There was no difference across the years in the median number of days in care for adults that were subsequently released but, in 2009, juveniles spent significantly more time in care prior to release than in the previous four years, although the reason for this is unclear. In 2009, three new aviaries were built which allowed staff the opportunity to spend more time assessing the birds. As a result, juveniles released in 2009, were heavier and were stronger fliers than juveniles released in previous years (D Hunter, personal observation 2009), during which birds were released once they had attained a suitable release weight and to free up aviary space for other birds. Keeping the birds in captivity for a longer period and allowing them to build-up surplus fat reserves may increase the likelihood of them surviving independently in the wild, although this remains to be tested.

Only 14% of adults and 31% of juveniles were released following rehabilitation. However, the post-release survival period for these birds is not known. The RSPCA has had only 15 ring recoveries (14 juveniles and one adult) from 1,086 woodpigeons ringed (1.4%) between 2000 and 2008. The recoveries showed survival ranging from 2–2,545 days (median = 231 days). The single adult recovered had only survived for two days following release and one of the juveniles recovered after 265 days was long dead and an accurate survival time could not be calculated. Excluding these, ten birds (76.9%) survived for at least eight weeks, with 46.1% surviving more than a year, compared to 85.3 and 36.7%, respectively for pulli ringed on the nest. Percentage recoveries were low for both groups (1.4% for rehabilitated birds and 2.7% for pulli ringed on the nest). Although this indicates that rehabilitated juveniles were able to survive independently following release, the small number of recoveries means that these data must be treated with caution as we have no knowledge of the fate of the majority of the released birds. However, rehabilitated birds in general have lower median periods from ringing to recovery (Joys *et al* 2003). In addition, the rehabilitated birds were ringed prior to release, having been in captivity for an average of 32 days and the non-rehabilitated birds were ringed as pulli and so were younger when ringed. Taking that into account, there may be little difference between the two groups. In future, radio-tracking studies and colour ring studies could be undertaken to determine short- and long-term survival. Haynes *et al* (2003) radio-tracked 19 adult and nine newly fledged woodpigeons caught on or near the nest to examine their ranging behaviour. Two of the juveniles were shot, the signal was lost for four and three returned to their natal area the following summer. These data were collected over an eight-year period making it difficult to interpret survival times. However, it is clear that both adult and juvenile rehabilitated woodpigeons could be radio-tracked to measure their movements and survival.

The rehabilitation of wildlife raises important ethical questions. Woodpigeons are abundant and are major pests of crops (Inglis *et al* 1997). They are also a common quarry species (Willock 1995) with 97% of farmers controlling numbers by shooting (Smith *et al* 1995). As a result it is questionable whether rehabilitation of woodpigeons has any value for the birds, particularly if they are likely to be shot following release. The small numbers released are likely to have no effect on the woodpigeon population. Wildlife rehabilitation has often been criticised as having little or no conservation value. However, those involved in wildlife rehabilitation rarely do it for conservation purposes (but see Cheyne 2007; Russon 2009). In most cases, rehabilitation is beneficial for animal welfare and is justifiable under certain conditions (Kirkwood & Sainsbury 1996), particularly where human activities have directly or indirectly resulted in the requirement for intervention. Euthanasia on welfare grounds is justifiable if wildlife casualties are unlikely to recover and are in pain or distress. In addition, it could be argued that by rescuing sick, injured or orphaned birds, that would otherwise have died interferes with natural selection if these individuals were less fit than their conspecifics. However, the small numbers involved are unlikely to have any impact on the gene pool.

Animal welfare implications

Wildlife rehabilitation is a popular global enterprise and it has obvious impacts on animal welfare. Criticism of wildlife rehabilitation in terms of its conservation value is unlikely to deter those individuals and organisations involved. Therefore it is vital that the welfare of the animals whilst in captivity and following release is assessed and constantly reviewed, allowing changes to protocols and informed decisions on euthanasia to be taken as soon as possible. Although many thousands of injured and orphaned wild animals taken into care are subsequently returned to the wild many more will die or require euthanasia to prevent further suffering. It is essential therefore for wildlife carers to identify those individuals with a poor prognosis as soon as possible and take action to prevent further suffering. We have demonstrated that age, weight on admission and severity of symptoms can be used to identify individual woodpigeons that are unlikely to survive to the release stage. We recommend that all wildlife rehabilitators utilise the factors tested here to better advise their admissions policy and to allow them to improve the welfare of wildlife casualties presented to them. Euthanasia at the earliest possible opportunity is the preferred outcome for those birds that are not likely to survive. We also recommend further post-release survival studies to determine whether rehabilitated woodpigeons (and other wildlife) can survive for a period of time that justifies the rehabilitation process.

Acknowledgements

Many thanks to all the staff at RSPCA Stapeley Grange, especially Andrew Smith, Rob Scrivens, Maxine Bland and Angela Garton, for collecting data. Thanks to Sinead Kelly for veterinary advice. Thanks also to Dr Rob Atkinson, Richard Thompson, Alison Charles and Rupert Griffiths. We are grateful to Jacquie Clarke at the BTO for leg-band recovery data. The BTO Ringing Scheme is funded by a partnership of the British Trust for Ornithology, the Joint Nature Conservation Committee (on behalf of: Council for Nature Conservation and the Countryside, the Countryside Council for Wales, Natural England and Scottish Natural Heritage), The National Parks and Wildlife Service (Ireland) and the ringers themselves. The authors are also grateful to three anonymous reviewers for their comments which greatly improved the original manuscript.

References

BirdLife International 2004 *Birds in Europe: Population Estimates, Trends and Conservation Status*. BirdLife Conservation Series No. 12. BirdLife International: Cambridge, UK

Boissy A 1995 Fear and fearfulness in animals. *Quarterly Review of Biology 70*: 165-191

Carlstead K 1996 Effects of captivity on the behavior of wild mammals In: Kleiman DG, Allen ME, Thompson KV and Lumpkin S (eds) *Wild Mammals in Captivity* pp 317-322. The University of Chicago Press: Chicago, USA

Cheyne SM 2007 The role of reintroduction in gibbon conservation: opportunities and challenges. In: Lappan SM, Whittaker DL and Geissmann T (eds) *The Gibbons: New Perspectives on Small Ape Socioecology and Population Biology*. Springer: New York, USA

Cousquer GO, Dankoski EJ and Patterson-Kane JC 2007 Metabolic bone disease in wild collared doves (*Streptopelia decaocto*). *The Veterinary Record 160*: 78-84

Fajardo I, Babiloni G and Miranda Y 2000 Rehabilitated and wild barn owls (*Tyto alba*): dispersal, life expectancy and mortality in Spain. *Biological Conservation 94*: 287-295

Field A 2005 *Discovering Statistics Using SPSS, Second Edition*. Sage Publications: London, UK

Garland L, Harris S and Baker P 2003 *An Evaluation of the Ethics and Implementation of Wildlife Rehabilitation. RSPCA, Annual Progress Report*. RSPCA: Horsham, UK

Gibbons DW, Reid JB and Chapman RA 1993 *The New Atlas of Breeding Birds in Britain and Ireland: 1988–1991*. T and AD Poyser: London, UK

Goldsworthy SD, Gliese M, Gales RP, Brothers N and Hamill J 2000 Effects of the Iron Baron oil spill on Little Penguins (*Eudyptula minor*). I. Post-release survival of rehabilitated oiled birds. *Wildlife Research 27*: 573-582

Haynes PJ, Inglis IR, Isaacson TJ and Fryday SL 2003 Woodpigeon *Columba palumbus* movements in eastern England: Woodpigeons range over greater areas during winter than summer with winter dispersion greatest in the first two winters following fledging. *Bird Study 50*: 33-38

Inglis IR, Isaacson AJ, Smith GC, Haynes PJ and Thearle RJP 1997 The effect on the woodpigeon (*Columba palumbus*) of the introduction of oilseed rape into Britain. *Agriculture, Ecosystems and Environment 61*: 113-121

International Wildlife Rehabilitation Council 2010 http://www.iwrc-online.org/index.html

Joys AC, Clark JA, Clark NA and Robinson RA 2003 *An investigation of the effectiveness of rehabilitation of birds as shown by ringing recoveries*. BTO Research Report No 324. British Trust for Ornithology: Norfolk, UK.

Kelly A and Bland M 2006 Admissions, diagnoses, and outcomes for Eurasian Sparrowhawks (*Accipiter nisus*) brought to a wildlife rehabilitation center in England. *Journal of Raptor Research 40*: 231-235

Kelly A, Goodwin S, Grogan A and Mathews F 2008 Post-release survival of hand-reared pipistrelle bats (*Pipistrellus* spp). *Animal Welfare 17*: 375-382

Kelly A, Scrivens R and Grogan A 2010 Post-release survival of orphaned wild-born polecats (*Mustela putorius*) reared in captivity at a wildlife rehabilitation centre in England. *Endangered Species Research 12*: 107-115

Kirkwood JK 2003 Introduction: wildlife casualties and the veterinarian. In: Best R, Cooper JE and Mullineaux E (eds) *BSAVA Manual of Wildlife Casualties* pp 1-5. British Small Animal Veterinary Association: Gloucestershire, UK

Kirkwood JK and Sainsbury AW 1996 Ethics of interventions for the welfare of free-living wild animals. *Animal Welfare 5*: 235-243

Leighton K, Chilvers D, Charles A and Kelly A 2008 Post-release survival of hand-reared tawny owls (*Strix aluco*) based on radio tracking and band return data. *Animal Welfare 17*: 207-214

Martell M, Redig P, Nibe J, Buhl G and Frenzel D 1991 Survival and movement of released rehabilitated bald eagles. *Journal of Raptor Research 25*: 72-76

Molony SE, Baker PJ, Garland L, Cuthill IC and Harris S 2007 Factors that can be used to predict release rates for wildlife casualties. *Animal Welfare 16*: 361 -367

Morris PA 1998 Hedgehog rehabilitation in perspective. *The Veterinary Record 143*: 633-636

Murton RK 1965 *The Woodpigeon*. Collins: London, UK

Naef-Daenzer B, Widmer F and Nuber M 2001 Differential post-fledging survival of great and coal tits in relation to their condition and fledging date. *Journal of Animal Ecology 70*: 730-738

Ringsby T, Saether B and Solberg E 1998 Factors affecting juvenile survival in House Sparrow *Passer domesticus*. *Journal of Avian Biology 29*: 241-247

Robertson CPJ and Harris S 1995 The condition and survival after release of captive-reared fox cubs. *Animal Welfare 4*: 281-294

Russon AE 2009 Orangutan rehabilitation and reintroduction. In: Wich SA, Utami SS, Mitra Setia T and van Schaik CP (eds) *Orangutans: Geographic Variation in Behavioral Ecology and Conservation* pp 327-350. Oxford University Press: Oxford, UK

Sharp B 1996 The post-release survival of oiled, cleaned seabirds in North America. *Ibis 13*: 222-228

Slater PS 2001 Breeding ecology of a suburban population of Woodpigeons *Columba palumbus* in northwest England. *Bird Study 48*: 361-366

Smith S, Harradine J and Batley J 1995 *Farmers, Woodpigeons and Woodpigeon Shooting*. British Association for Shooting and Conservation: Wrexham, UK

Snow DW and Perrins CM 1998 *The Birds of the Western Palearctic (Concise Edition)*. Oxford University Press: Oxford, UK

Teixeira CP, Schetini de Azevedo C, Mendl M, Cipreste CF and Young RJ 2007 Revisiting translocation and reintroduction programmes: the importance of considering stress. *Animal Behaviour 73*: 1-13

Werner CV, Peach WJ and Browne SJ 1997 *Survival Rates of Rehabilitated Guillemots*. British Trust for Ornithology: Thetford, UK

Willock C 1995 *The Book of the Woodpigeon*. White Lion: UK

Wingfield JC, Hunt K, Breuner C, Dunlap K, Fowler GS, Freed L and Lepson J 1997 Environmental stress, field endocrinology, and conservation biology. In: Clemmons JR and Buchholz R (eds) *Behavioral Approaches to Conservation in the Wild* pp 262-276. Cambridge University Press: Cambridge, UK

https://doi.org/10.1017/S096272860000316X Published online by Cambridge University Press