



# British Birds

Established 1907; incorporating 'The Zoologist', established 1843

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## The re-establishment of Red Kite breeding populations in Scotland and England

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**ABSTRACT** The sight of Red Kites *Mikvus mikvus* gliding and wheeling effortlessly in the skies of Scotland and England was once very familiar. Until recently, however, Red Kites were absent from much of this former range within the UK: a long-standing legacy of past persecution. Conservation measures now in hand have started to redress this. These measures were initiated during 1989-94, when the Joint Nature Conservation Committee (initially the Nature Conservancy Council) and the Royal Society for the Protection of Birds undertook a joint project to re-establish breeding populations of Red Kites in Scotland and England by translocation of nestlings from Sweden, Spain and Wales to sites in northern Scotland and southern England. Totals of 93 nestlings were released at each of these two sites. As a result, Red Kites bred successfully in Scotland and England in 1992. These populations are

increasing, and wild-bred Red Kites produced by released birds are now being recruited into the breeding population. In 1996, at least 37 pairs bred in southern England and 16 pairs in northern Scotland. This paper reports on the background and progress of this project and the development of this work into a wider operational recovery programme by English Nature, Scottish Natural Heritage and the RSPB.

The Red Kite *Milvus milvus* has recently been classified as a Category 4 Species of European Conservation Concern, and is considered to have a favourable conservation status, with a World population of 19,000 to 37,000 pairs (Tucker & Heath 1994) confined virtually within Europe (table 1). Populations in south and east Europe, however, are declining and fragmented, while along the adjacent fringe of western Asia and North Africa Red Kites are virtually extinct. Only in northwest and central Europe are numbers recovering around the main Red Kite population centres in Germany and France. The future of these populations is by no means certain, as large numbers overwinter in southern Europe, where human pressure is reducing their range and numbers (Evans & Pienkowski 1991; Antonio Montero 1996) and recent intensification of agriculture in the eastern part of Germany is causing concern for breeding Red Kites there (M. Stubbe *in litt.*).

**Table 1. Summary of World breeding status of the Red Kite *Milvus milvus*.**  
Countries ranked in order of population size.

Country	Population (breeding pairs)	Status	Census date	Reference
Germany	12,000-25,000	Stable	-	Tucker & Heath (1994)
Spain	3,375-3,760	Decline	1991-94	Viruuela (1992-94)
France	2,300-2,900	Increase	1979-82	Thiollay & Terrasse (1984)
Sweden	650	Increase	1995	Kjellén (1996)
Poland	300	Increase	-	Evans & Pienkowski (1991)
Switzerland	235-300	Increase	1985-87	Mosimann & Juillard (1988)
United Kingdom	182	Increase	1996	Unpublished
Italy	130-170	Decrease	1990-92	Cortone <i>et al.</i> (1994)
Portugal	100	Stable	1985-89	Evans & Pienkowski (1991)
Russia	0-50	Decline	-	Tucker & Heath (1994)
Czech Republic	20-25	Stable	1989	Evans & Pienkowski (1991)
Morocco	20-24	Decline	-	Thévenot <i>et al.</i> (1985)
Belgium	15-20	Increase	1979-89	Evans & Pienkowski (1991)
Romania	10-20	Decline	-	Tucker & Heath (1994)
Slovakia	10-20	Stable	-	Tucker & Heath (1994)
Luxembourg	12-15	Stable	1990	Evans & Pienkowski (1991)
Denmark	10-15	Stable	1980-89	Evans & Pienkowski (1991)
Belarus	0-10	Decline	1990	Tucker & Heath (1994)
Ukraine	5-8	Decline	1988	Tucker & Heath (1994)
Austria	5-6	Increase	1991	Meyburg (1991)
Latvia	0-5	Decline	-	Tucker & Heath (1994)
Lithuania	1-2	Decline	1985-88	Tucker & Heath (1994)
Moldova	1	Decline	1990	Tucker & Heath (1994)
Cape Verde Isles	'Few'	Decline	-	Evans & Pienkowski (1991)

## Conservation action in the UK

The first efforts to save the Red Kite began at the beginning of this century with the initiation of nest-protection schemes in Wales (Lovegrove 1990). Such efforts were ineffective initially, and the Red Kite nearly became extinct in the UK during the 1930s (Davis 1993). In the years after World War Two, however, the Nature Conservancy (superseded by the Nature Conservancy Council in 1971, and the Countryside Council for Wales in 1990) and the RSPB organised the monitoring, research and protection, and this helped the range expand within Wales (Lovegrove 1990). This work is now undertaken by the Welsh Kite Trust and, in 1996, the Trust reported at least 127 breeding pairs in Wales, with a further 28 pairs occupying territories (Welsh Kite Trust 1996). The current breeding distribution still represents a small fraction of the former range of the Red Kite within the UK, as fewer than 5% of all 10-km National Grid squares are occupied. In comparison, another medium-sized raptor with a similar ecology, the Common Buzzard *Buteo buteo*, breeds in 41% of Britain's 10-km squares (Gibbons *et al.* 1993) and the potential range would be much larger if illegal persecution were to cease. Recolonisation of former nesting areas in England and Scotland, which still remain suitable for Red Kites, is unlikely to occur naturally, as there are three factors currently restricting the population's ability to expand within Wales. These are:

1. Relatively low breeding productivity of the Welsh population (0.84 young per breeding pair in 1991 to 1993, Newton *et al.* 1994) compared with populations in France and Germany (1.5 to 1.8 young per breeding pair, Evans & Pienkowski 1991). This is due mainly to poor habitat quality and the activities of egg-collectors (Newton *et al.* 1994).
2. Illegal poisoning, which reduces the number of individuals recruited into the breeding population and also removes a proportion of established pairs each year. During 1971-93, a total of 44 Red Kites was confirmed to have been poisoned in the UK (Cadbury 1991; Fletcher & Hunter 1993; Fletcher *et al.* 1991, 1992, 1994).
3. A low rate of immigration from larger Continental populations (May *et al.* 1993) has meant that the rate of population growth within the UK has, until recently, been dependent upon the breeding productivity and survival of the population within Wales.

## Re-establishment proposals

Following natural recolonisation by the Osprey *Pandion haliaetus* (Waterston 1971) and the successful re-establishment of the White-tailed Eagle *Haliaeetus albicilla* (Love 1983), attention in Scotland turned to the Red Kite. A proposal to translocate Red Kites from Wales to Scotland was made in 1981 (by RHD), but this was unsuccessful. A further proposal, to re-establish Red Kites in Scotland with potential donor stock coming from continental Europe, was raised again within the RSPB in 1984. This resulted in the formation of a joint NCC/RSPB Project Team in 1986 to assess measures to facilitate range recovery of the Red Kite within the UK.

The Project Team recognised that the long-term existence of any species is dependent upon maintaining as wide a distribution as possible. Once populations

are fragmented or restricted, they become increasingly vulnerable to local environmental pressures. Hence, conservation measures which make Red Kites less dependent on events in just one area would not only help to restore a significant member of our fauna throughout Britain, but also make a major contribution to the international conservation of this species, and help to safeguard a part of the World's biodiversity. After two years of careful consideration, the Project Team concluded that re-establishment was an appropriate conservation measure and should be undertaken in Scotland and England. IUCN criteria (Green 1979) were used to assess the eligibility of the Red Kite as a candidate for re-establishment. This assessment (Evans 1994) is summarised as follows:

1. *There should be good historical evidence of former natural occurrence.*

*The Red Kite was once an abundant resident and migratory breeder over most of Britain, but became extinct as a nesting species in England in 1871 (Fisher 1947) and in Scotland in 1917 (Baxter & Rintoul 1953). A small population survived in a remote area of central Wales which is now recovering slowly as a result of protection.*

2. *There should be a clear understanding of why the species was lost. In general, only those lost through human agency and unlikely to recolonise naturally should be candidates for re-establishment.*

*Human persecution was the key factor responsible for the disappearance of Red Kites over most of the UK. Persecution was first recorded in the fifteenth to sixteenth centuries, after legislation encouraged persecution through bounty payments. It continued through the seventeenth to twentieth centuries, as a result of indiscriminate killing and collecting.*

3. *The factors causing extinction should have been rectified.*

*These have largely been corrected by changes in legislation and public attitudes. Persecution that occurs today is illegal and unlikely to exterminate Red Kites in the UK, but it still undermines population growth and range expansion.*

4. *There should be suitable habitats of sufficient extent to support the re-established population and allow it to expand.*

*It is considered that the majority of the Red Kite's former range in the UK still remains suitable in terms of nesting, feeding and roosting habitats. The current range occupied in Wales appears not to be the preferred habitat, but was simply the last refuge from human persecution.*

5. *The donor population from which individuals are translocated should be as close as possible genetically to that of the original native population.*

*Obtaining all birds for re-establishment from within Britain (i.e. from Wales) was not feasible on account of small population size and slow rate of growth. Recent evidence (May *et al.* 1993) suggests that there are unlikely to be any major natural genetic differences between British and Continental populations (as these were parts of a continuous population that has recently become fragmented by persecution).*

6. *The loss of individuals taken for re-establishment should not prejudice the survival of the population from which they were taken.*

*Red Kite nestlings were obtained from populations which could compensate for their loss (Continental populations) or from nests at which nestlings were unlikely to fledge (Welsh population).*

Leading on from these decisions, the NCC and the RSPB initiated a joint translocation experiment in 1989 to evaluate whether and how Red Kite

population centres could be re-established in formerly occupied areas outside Wales. In 1990, as a result of reorganisation of the NCC by Government, the work was taken forward by the Joint Nature Conservation Committee, being undertaken by a large team of ornithologists.

## Re-establishment stage by stage

### *Selecting release sites*

The Project Team recommended that experimental release sites should be established in the eastern districts of northern Scotland and in southern England. The Project Team agreed that potential sites should be judged on the following criteria (Lovegrove, Elliott & Smith 1990). They should be:

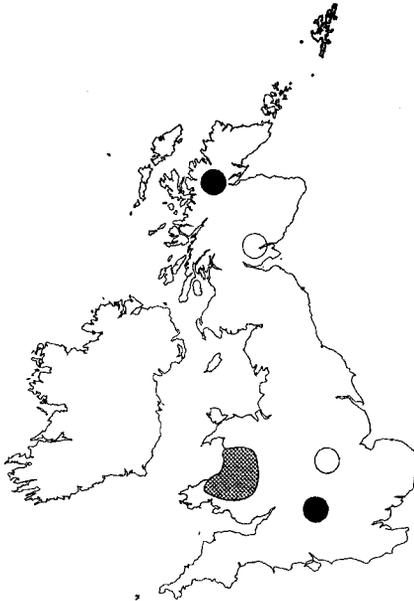
- a. In a sufficiently large area of suitable habitat and not an isolated patch of good habitat in an otherwise unsuitable area.
- b. In a region with a sustainable food supply in both winter and summer.
- c. In an area where the breeding success of Common Buzzards (if present) indicated an abundant food supply.
- d. In an area free of illegal poison baits.
- e. In an area of low annual rainfall, below an altitude of 350 m above sea level.
- f. In an area where the local community was favourable to the project.

In 1988-89, landowners and farmers were approached in several areas that the Project Team had identified as suitable, and release sites were selected.

### *Establishing release sites*

Fig. 1 gives the approximate locations of the release areas (exact details are not publicised by the country agencies, the JNCC or the RSPB). In northern Scotland, two aviary complexes (Appendix 1) were built about 12 km apart in an area of farmland interspersed with woodland and rough grazing, which included several villages as well as a network of public roads. In southern England, another two aviary complexes, based on a design by Llewellyn (1990), were built 0.5 km apart on two adjacent estates with areas of woodland and mixed farming covering a combined area of 2,600 ha. The aviaries (Evans *et al.* 1994; Appendix 1) complied with Government quarantine standards (Anon. 1989).

Food for the Red Kite nestlings was collected mainly from local gamekeepers and stored frozen until needed. The main food items in northern Scotland were Rabbits *Oryctolagus cuniculus* shot with a .22-calibre rifle. In addition, young crows, mainly Rooks *Corvus frugilegus*, farmed Atlantic Salmon *Salmo salar*, trout (*Oncorhynchus mykiss* and *S. trutta*) and smaller numbers of assorted mammals (road kills) were obtained. In southern England, fewer rifle-shot Rabbits were available and more legally trapped items (Grey Squirrels *Sciurus carolinensis*, Rabbits, mustelids and crows) were supplied by gamekeepers and were not killed specifically for the project. Trapping by gamekeepers is undertaken annually in spring as part of game management practice (mustelids and crows) and pest control (Grey Squirrels and Rabbits). Prey items killed with shotguns were avoided to prevent ingestion of lead shot.



**Fig. 1.** Approximate locations of populations of Red Kites *Milvus milvus* in the UK. Shaded grey area denotes breeding range within Wales. Filled circles refer to where Red Kites were released in northern Scotland and southern England in 1989 to 1993/94, and where Red Kites are now breeding. Open circles refer to the new release areas in central Scotland and the East Midlands of England, established in 1995/96.

#### *Obtaining release stock*

In 1988, the Swedish Red Kite Project (Sylvén 1976) indicated that it might be possible to collect Red Kite nestlings from nests in Skåne, southern Sweden, during the period when they were being ringed as part of an intensive study (Kjellén 1995). The WWF-funded project has undertaken winter feeding and annual monitoring of the Swedish Red Kite population since 1976 (Kjellén 1994) and has recorded its rapid recovery from 50 pairs in the 1970s to an estimated 650 pairs in 1995 (Kjellén 1996). This led to an official request, from the RSPB, to collect Red Kite nestlings, which was granted by the Swedish Government.

The first young were collected on 10th June 1989. It was decided to take young kites of approximately four to six weeks of age because they could thermo-regulate without parental brooding and could feed themselves. Smaller nestlings would have required a greater level of artificial care, with a greater risk of imprinting on and/or conditioning to humans. As the sex of each nestling could not be ascertained, nestlings of appropriate age were selected arbitrarily, since concentrating solely on large or small nestlings could, unwittingly, have introduced a heavy sex bias into the founder population. As nests in Skåne often contained three or even four nestlings, two young were collected from nests with four nestlings and one young from nests with three nestlings. This ensured that pairs always continued to rear a brood, since successful nests are more likely to be re-used in subsequent years (Walters Davies & Davis 1973). Young were also collected from nests throughout the population, so that genetic variability was as high as possible. These guidelines for collecting Red Kite nestlings were followed each year.

The collection of nestlings covered a period of three days. In 1989, ten were collected, and in the following four years 20-24 per year. Each nestling was ringed and kept separately in a cardboard box at Lund University field station. The nestlings were fed by hand twice a day on small fish; they were given a full crop each time. In 1989, four of the ten Swedish nestlings were taken to England, while during 1990-93 all those imported from Sweden were released in Scotland (table 2).

**Table 2. Origins of Red Kites *Milvus milvus* released in England and Scotland during 1989-94.**

Origin	Release site	1989	1990	1991	1992	1993	1994
Skåne	Scotland	6	19	20	24	24	-
Skåne	England	4	-	-	-	-	-
Wales	England	1	2	4	-	-	-
Navarra	England	-	11	11	10	10	-
Aragón	England	-	-	-	10	10	20

During 1990-94, the central and provincial governments in Spain agreed to license the collection of Red Kite nestlings from the provinces of Navarra and Aragón (table 2) as their Red Kite populations were comparatively large (Elósegui Aldasoro 1985; Compared Carbo *in litt.*) and productive and could compensate for the loss of a small number of nestlings. Nests were located in early March, when Red Kites were in the early stages of incubation but before the nest trees had acquired foliage. The main method used was to drive along a road or track, scanning the surrounding trees for likely nest structures. The best areas to find nests were in trees growing along river banks, as these provided the most suitable nest sites. Nest sites in large forests (especially in Navarra) were much more difficult to locate, while those close to villages were often located with help from local inhabitants. The most frequent nest trees used were Black Poplar *Populus nigra* and oak *Quercus*. Once an occupied nest was located, a rough hand-drawn sketch map was made, to ensure that the nest could be re-found for further checks. The nestlings were collected during the last week of May or the first week of June, following the same guidelines as those used in Sweden. In Navarra, nestlings were collected from a total of 41 nests during 1991-93; single nestlings were taken from 38 broods, and two nestlings were taken from three broods (two nestlings were not released). In Aragón, nestlings were collected from a total of 23 nests during 1992-94 (some nests were 'harvested' more than once); single nestlings were collected from 30 broods, and two nestlings were collected from five broods. The average brood size of nests from which nestlings were taken was 2.4 nestlings. Depending on weather conditions and work commitments of the Spanish conservationists, it took five to seven days to collect 20 nestlings from Aragón and Navarra. After collection, the nestlings were ringed and kept together in aviaries at a raptor-rehabilitation centre in Navarra and then flown to England during the period 31st May to 8th June.

The English operation benefited also from the donation of seven Red Kite nestlings from Wales (table 2), where field workers have been operating a small-scale rescue service since 1986. The nestlings were taken as eggs from five nests that were at risk from egg-collectors. Dummy eggs (some of which were stolen subsequently by egg-collectors) replaced the original clutch to ensure that the

pair continued to incubate. The real eggs were incubated artificially and the chicks were reared by a captive female Common Buzzard until four to six weeks old. At that age, they were transferred to the release aviaries in southern England.

The applicability of captive breeding was investigated by JNCC. Seven adult females and two adult males that could not be rehabilitated were provided by Grupo de Rehabilitacion de la Fauna Autoctona (GREFA) and the Buitrago Raptor Rehabilitation Centre in Spain in November 1989. A further male and female were obtained in 1991, when a released Red Kite from southern England and a wild Red Kite from Wales could not be rehabilitated. No nestlings have yet been reared, although two pairs have laid infertile clutches. Captive breeding is an extremely difficult technique and the use of wild stock in the release programme was therefore appropriate, particularly as IUCN criteria 5 and 6 were not violated.

#### *Care of Red Kites in captivity*

The care of nestlings in captivity was essentially the same each year, so no distinction is made between years. Nestlings were matched with nestlings of similar age and size and placed on an artificial nest platform. Depending on numbers available, two to four nestlings were placed in each aviary compartment. They were fed on finely minced meat and bone during the first few days after import. Then, depending on age, the food was either chopped up finely or minced (four to six weeks old), skinned (six to nine weeks old) or given whole (after ten weeks). Food was supplied daily in excess amounts through a small lockable hatch beside the nest platform. Initially, two feeding visits were made per day, but this was reduced to a single visit as the birds got older. The amount of food required varied and was adjusted depending on the amount consumed. An indication of the food required is shown from the records kept in southern England (table 3). Contact with the birds was kept to an absolute minimum, to reduce the chance of imprinting on and conditioning from their human keepers. Inspections were normally made through tiny inspection holes in the wooden-panelled sides of the aviaries, which reduced human contact considerably by providing a suitable screen.

A veterinary officer made at least one visit to each release site during the period of captivity to check the health of each bird. This involved taking a 2-ml blood sample from each nestling for haematological examination, sex determination and DNA 'finger-printing' studies, and a physical examination to ensure that each nestling was suitable for release. Three imported Red Kites, representing 1.6% of the total, could not be released into the wild. One of these was imported from Sweden in 1990 and, despite veterinary attention, died soon after it was introduced to the aviary in Scotland. The cause of this problem was unknown. The two others were taken from nests in Spain and imported into England in 1991. One (the runt of a brood of three) was found to have abnormal bone growth only three days after importation, while the other died from an acute infection (trichomoniasis, caused by the flagellate protozoan parasite *Trichomonas gallinae*) five days after importation. Two other nestlings caught this infection, but were successfully treated with antibiotics (metronidazole).

**Table 3. Individual food items supplied to Red Kites *Milvus milvus* reared and released in southern England during periods in June, July and August 1990 and 1991.**

Note: not all food was consumed, but is included here to give an indication of how much was required. None of the items was killed specifically for the project.

	1 Jun-28 Jul 1990	7 Jun-10 Aug 1991	25 Jun-27 Jul 1991
No. of days	58	65	32
No. of Red Kites	11	11-15	2
BIRDS			
Mallard <i>Anas platyrhynchos</i>	-	1	-
Common Pheasant <i>Phasianus colchicus</i>	-	3	-
Wood Pigeon <i>Columba palumbus</i>	15	22	-
Eurasian Jay <i>Garrulus glandarius</i>	-	4	-
Magpie <i>Pica pica</i>	81	41	8
Carrion Crow <i>Corvus corone</i>	56	24	1
Rook <i>C. frugilegus</i>	20	-	-
Jackdaw <i>C. monedula</i>	3	1	1
MAMMALS			
Stoat <i>Mustela erminea</i>	4	4	-
Weasel <i>M. nivalis</i>	4	8	-
Fox <i>Vulpes vulpes</i>	10	3	-
Rabbit <i>Oryctolagus cuniculus</i>			
small	22	40	3
medium	82	43	14
large	25	42	-
Grey Squirrel <i>Sciurus carolinensis</i>	18	136	9

To facilitate visual identification of individual Red Kites in the field, both wings of each nestling were marked with a uniquely labelled wing-tag, which was coloured to denote the year of fledging (table 4, Appendix 2). A tail-mounted radio transmitter was also fitted to the Red Kites released during 1989-93 (Appendix 2), to facilitate the collection of information on the daily movements of individual birds.

During the period of captivity, there were no recorded instances of aggression between nestlings, and by the time of release (at ten to twelve weeks old) all birds were proficient fliers and showed surprisingly good manoeuvrability within the confines of their relatively small aviary.

**Table 4. Wing-tag colours used for each cohort of Red Kites *Milvus milvus* released or naturally fledged in Scotland and England.**

Year	Scotland	England
1989	Orange	Orange
1990	Blue	Blue
1991	Yellow	Yellow
1992	Lime-green	Black
1993	Red	Green
1994	White	Orange

### *Release into the wild*

Releases took place during the period 26th July to 3rd August in northern Scotland and during 10th July to 3rd August in southern England. A total of 93 Red Kites was released in each area, and releases were suspended in southern England in 1994 and in northern Scotland in 1993 (table 2). Prior to opening the release doors, food was placed on or near the aviaries, and the birds were released in batches of up to ten per day. In northern Scotland, the release doors were opened before dawn. In southern England, however, no particular time of day was chosen and releases were undertaken sometimes in the presence of people. It was important that releases were not undertaken during periods of heavy rain.

In both release areas, Red Kites settled in the vicinity of the aviaries after release and remained together in loose groups, returning to feed at food stations established on or near the release aviaries. In northern Scotland, up to ten Rabbits or an equivalent amount of fish was placed on top of each aviary each night whilst the Red Kites were roosting. In southern England, it was found that small food items on their own would be carried off by individual Red Kites, depleting the food supply very quickly. To prevent this happening, large items, such as carcasses of Fox or deer (Fallow Deer *Dama dama*, Muntjac *Muntiacus reevesi*), were provided, but these had to be slit open in several places as the skin was too tough for the Red Kites to break through by themselves. The food stations were maintained daily for a period of up to three to four weeks in both areas. During this time, the number of juveniles visiting the food stations declined as they began exploring the surrounding countryside in search of natural foods. Red Kites released in previous years and Common Buzzards also visited food stations.

### *Establishment of breeding centres*

After release, juvenile Red Kites moved around considerably, and many individuals left the release areas at some point during their first year. Radio telemetry and wing-tag observations allowed the dispersal of some birds to be tracked. In northern Scotland, some Red Kites dispersed south to southern and southwestern Scotland and Northern Ireland, and a few even reached the Republic of Ireland and Cornwall in their first autumn. Survivors returned in the following spring. In southern England, Red Kites dispersed either in their first autumn or during the following spring, and were recorded in Wales, East Anglia, Cornwall, Kent and northern France. Survivors varied considerably in the time taken to return to southern England: some returned after a few days, while others took several months. Those individuals that did not disperse formed communal roosts. The numbers attending these roosts during winter increased over the years as more kites were released and as juveniles and subadults returned to their subsequent release areas after dispersal. In England, 76% of all released Red Kites survived their first year and at least 62% of those released during 1989-92 bred at least once during 1991-94. In northern Scotland, at least 34% of released Red Kites are known to have been recruited into the breeding population in 1994. In March 1995, the population was estimated to be 117 individuals in southern England and 50 individuals in northern Scotland.

The first signs of courtship and breeding behaviour by kites in their first year were observed in 1991 in both areas. Two pairs bred (i.e. laid eggs) in southern

England, but both attempts failed. In 1992, Red Kites released by the translocation programme bred successfully in both areas. This achieved a major target for the project and represented the first successful breeding in England and Scotland for over a century. The breeding populations in both release areas have increased each year since 1991 (table 5), and in 1994 Red Kites reared in the wild by pairs established by the release programme themselves reared young for the first time.

**Table 5. Status and breeding success of populations of Red Kites *Milvus milvus* established as a direct result of the release programme in northern Scotland and southern England in 1991-96.**

Note: in 1995 and 1996, not all breeding pairs were located.

Year	No. of single males on territory		No. of non-breeding pairs located		No. of breeding pairs located		No. of successful pairs		No. of young fledged	
	SCOTLAND	ENGLAND	SCOTLAND	ENGLAND	SCOTLAND	ENGLAND	SCOTLAND	ENGLAND	SCOTLAND	ENGLAND
1991	-	-	-	-	-	2	-	0	-	0
1992	3	-	1	3	1	4	1	4	1	9
1993	4	1	3	3	5	9	3	8	7	14
1994	5	-	3	2	8	20	6	17	13	37
1995	-	-	2	2	15	24	11	22	26	55
1996	-	-	5	-	16	37	15	33	38	80

All nests were built at heights ranging from 8-25 m in mature trees. In Scotland, Red Kites nested mainly in Scots Pine *Pinus sylvestris*, but also in other trees, including Beech *Fagus sylvatica*, oak *Quercus*, Douglas Fir *Pseudotsuga menziesii* and Sitka Spruce *Picea sitchensis*. The tree species favoured for nesting in southern England were Beech and oak, but other species—notably Sycamore *Acer pseudoplatanus* and White Poplar *Populus alba*—have also been utilised. The nest position varied depending on the suitability of the site, and was built either from scratch or on top of another structure such as an old Red Kite nest, other raptor nest or squirrel drey.

The performance of each breeding population created by the re-establishment project is similar to or better than that of the donor populations from which they were taken (Newton *et al.* 1994; Kjellén 1994; A. Senosian *in litt.*). In comparison with the isolated but self-sustaining population in Wales, the re-established populations are more productive (with several cases of four-egg clutches and fledged broods of four young) and initiate breeding at an earlier age. At least 115 young have fledged in southern England and 47 young in northern Scotland during 1992-95. In 1996, not all nests were located; even so, 80 young were reared by 37 breeding pairs in southern England (Snell, McQuade & Stevens 1996), while in northern Scotland 38 young were reared by 16 breeding pairs. Predictions of population growth based on breeding and survival data indicate that the populations are self-sustaining and should continue to expand without the need for further releases at these locations.

### Conclusions and future implications

The joint JNCC/RSPB re-establishment project has been a success and its

achievements can be summarised as follows:

1. The Red Kite was a suitable candidate for re-establishment in the UK as assessed against IUCN criteria.
2. The Red Kite can be successfully translocated and released into the wild without jeopardising donor populations, demonstrating that such a scheme is practical using the techniques developed.
3. The released Red Kites became independent in the wild and a significant number has survived.
4. The breeding performance of successful pairs established by the project is at least as good as those of the populations from which the released birds were taken, demonstrating the suitability of the environments into which they have been released.
5. Nestlings reared in the wild by pairs established by the project are breeding in the re-established populations.
6. Effective monitoring has demonstrated that the established populations are expanding.

We have learnt much from this project. The collection and translocation of Red Kites from one country to another was a successful operation. It appears that much of the UK is suitable for Red Kites so long as they are not illegally persecuted. The breeding populations re-established in northern Scotland and southern England demonstrate that the most productive areas for Red Kites are not necessarily where the remnant Welsh population now survives. Past persecution removed the species from areas of high human population, which often coincided with the most productive land. By re-establishing Red Kites in such areas, the project has demonstrated that, when persecution is absent or where it can be reduced, a faster rate of population growth can be achieved.

The Government nature conservation agencies and the RSPB are now utilising the techniques developed in a programme to facilitate restoration of the Red Kite throughout its former range in the UK. This will be achieved by linking the existing breeding populations in England, Scotland and Wales, since one large population is less vulnerable than several smaller isolated populations. To promote linkage, English Nature and the RSPB (Carter *et al.* 1995) have established a new release site in the East Midlands of England (fig. 1) and released 11 Red Kites in 1995 and 16 in 1996. These birds were mainly imported from Segovia and Salamanca in Spain, although one was obtained from Wales and another (from Aragón) was rehabilitated from southern England. In Scotland, the RSPB and Scottish Natural Heritage have established a new release site in central Scotland and released 19 Red Kites (imported from Germany) in 1996. The country agencies and the RSPB will continue with the effective monitoring of the established breeding populations to ensure that their favourable conservation status is maintained. It is hoped that, by the year 2000, there will be five breeding populations in the UK, exceeding 350 breeding pairs in total.

### Acknowledgments

We are grateful to the organisations helping in the provision of Red Kites: WWF-Sweden, Skånes Ornitologiska Förening and The Swedish National Environmental Protection Board in Sweden, and Gobierno de Navarra (Servicio de Medio Ambiente) and Gobierno de Aragón (Departamento de Medio Ambiente) in Spain. In particular, we are grateful for the help received

from Johnny Karlsson, Ulf Sandnes and Lis-Britt Ingelög in Sweden. In Wales, we thank Dr N. Fox, P. Walters Davies, A. V. Cross, P. E. Davis, and members of the Welsh Kite Trust for their help in the provision of seven Welsh Red Kites to the project.

We acknowledge the support received from Instituto Nacional para la Conservacion de la Naturaleza (especially Dr B. Heredia and V. Garcia), Institute of Zoology at London Zoo (Dr J. K. Kirkwood), Department of Genetics at Nottingham University (Dr D. T. Parkin) and the estates that provided the release facilities (which at present have to remain anonymous). The Royal Air Force (Commanding Officers at RAF Kinloss and Fl. Lt S. Rooke) transported Red Kite nestlings from Sweden. Malmö Airport kindly waived landing fees. British Airways Assisting Conservation programme (R. Hall MBE) provided JNCC with air travel and Conoco UK Ltd and the Mrs Gillman Trust gave financial support to the RSPB. The operational work in England was undertaken and funded by NCC (1989-90) and JNCC (1990-95), while WWF-Sweden helped to fund work in Sweden. Gobierno de Navarra (Servicio de Medio Ambiente) and Gobierno de Aragón (Departamento de Medio Ambiente) funded the work in Spain. Since 1994, the work in Scotland has been funded jointly by Scottish Natural Heritage and the RSPB, while in England the work has been funded by English Nature and the RSPB since April 1995.

The experimental re-establishment project was a joint JNCC/RSPB programme; the RSPB took the operational lead in Scotland, and the JNCC (initially NCC) in England. Officers responsible for the project in Scotland were: R. H. Dennis, assisted by C. Crooke in 1988-91, R. F. Porter (1989-91), Dr T. J. Stowe (1991-94), Dr M. I. Avery (1994) and Dr I. P. Bainbridge (1995) for the RSPB, and Dr G. P. Mudge (1994-95) for SNH; in England, the officers responsible were Dr M. W. Pienkowski (1989-91) and Dr C. A. Galbraith (1991-95) for NCC and JNCC. The project officers who undertook the work for the RSPB in Scotland were: D. Doody (1989), A. Knight (1990), D. C. Orr-Ewing (1991-93), R. Evans (1993) and L. O'Toole (1993-95). In England, the project officers for NCC and JNCC were I. M. Evans (1989-95), J. Smith (1993-94) and N. Snell (1994-95), while Dr E. Bignal (JNCC) and E. E. Green (EN) gave invaluable help. A project team advised; this comprised Dr M. W. Pienkowski (Chairman, JNCC), Dr C. A. Galbraith (JNCC), Dr M. I. Avery (RSPB), N. Crockford (RSPB), Dr N. Fox, R. H. Dennis, Professor I. Newton (Institute of Terrestrial Ecology), together with representatives from the RSPB, English Nature, Scottish Natural Heritage and the Countryside Council for Wales.

A large number of individuals (including gamekeepers, farmers and naturalists), organisations and sporting estates have already helped in the project, but, for reasons of site-security, it is not yet possible to acknowledge their help publicly. We are nonetheless extremely grateful, and hope to be able to say more at a later date.

Finally, we thank Drs R. W. Summers, M. I. Avery, I. P. Bainbridge, R. E. Green, T. J. Stowe and C. A. Galbraith for their helpful and constructive comments on earlier drafts.

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### Appendix 1. Release aviaries

In northern Scotland, an aviary containing two compartments was constructed in 1989 in an area of mature Scots Pine *Pinus sylvestris* and birch *Betula* woodland overlooking hay meadows and rough grazing, adjacent to a large commercial conifer wood. In 1990, a three-compartment aviary complex was established at another site 12 km away in a small stand of mature pine trees overlooking meadows and a wooded valley. In 1993, one further compartment was added at the original aviary. The dimensions of each aviary compartment were 3.66 × 3.05 × 2.44 m high. Each compartment had a double layer of wire-mesh netting with a gap of approximately 1 cm that covered the front section as well as half of the side. The wire mesh was dug into the ground to a depth of 1 m to exclude mammalian predators. A double release door was situated in the top front section of the aviary and could be opened and shut by means of a pulley system operated from the back of the aviary. Entry into each compartment was gained through a double door at the back of the aviary. In one corner of each compartment, there was an artificial platform on which a stick nest, lined with moss, grass and wool, was placed. This was sheltered by a wooden roof on top of the aviary. The floor of the aviary was covered with softwood bark, and natural dead trees, leading out from the nest platform, provided perches. A lockable food hatch provided direct access to the nest platform.

In southern England, two single-compartment aviaries were built in 1989 about 0.5 km apart on one estate in a secluded area some distance away from public footpaths on opposite sides of a small wooded valley, in sight of each other. In 1990, one aviary was destroyed during severe gales and this site was abandoned. To accommodate more kites in 1990, a further two compartments were added to the surviving aviary and a new three-compartment aviary was established about 0.5 km away in a large woodland clearing on an adjacent estate. Each aviary compartment was 2.44 m high and covered an area of 6.10 × 2.44 m constructed of wood with all four sides panelled. The front of each aviary was fitted with a release door (2.44 × 1.22 m) which was opened only on the day of release. This was covered on the outside by 1.25-cm wire-mesh netting and on the inside with 2.50-cm mesh of soft plastic 'Netlon Parkguard'. A wooden platform (0.75 × 0.75 m) was built in a back corner of each compartment on which newspaper and green foliage was placed as a crude nest. This was sheltered by a wooden section of roof 2.44 × 1.22 m. The remaining area of the roof was covered by the same double layer of mesh netting as the release door. Access to the aviary was gained only through a double-door system at the rear. Two horizontal perches were provided across the full 2.44-m width of each aviary, near the front and rear. The rear perch was connected to the nest platform on one side and to the floor on the other by a diagonal perch, allowing a grounded bird access to the nest platform. Each aviary was protected by a skirt of wire mesh around the outside. An inner layer of wire mesh covered the entire basal area and supported a 'Permalite' roofing-felt floor.

### Appendix 2. Fitting of monitoring marks

When nestlings were six to eight weeks old, both wings were marked with a wing tag which was coloured to denote the year of fledging. The tags were made from sheets of PVC-coated nylon mesh, which had the advantage of being light in weight, durable and flexible. Initially, the shape

of the tag denoted whether the bird was of Welsh, English or Scottish origin, but in 1993 a common shape was adopted. Later versions of Scottish tags incorporated additional coloured (Sericol screen ink) strips painted along the trailing edge of the tag, the colour combination being unique to each bird. An alphanumeric label was painted onto the front of the tag for identification of each bird. White (Sericol screen ink) labels were favoured as they could be read at much greater distances than black labels. A contact telephone number was also painted on the reverse of each tag so that, if the bird was found, the JNCC or the RSPB could be contacted immediately.

The tags were fitted to each wing by piercing the patagium about 3 cm from the carpal joint with a 1.6-mm-diameter nylon pin or a stainless-steel wire (0.9-mm-diameter). The tag was attached to the pin above and below the wing and held in place by two 9.5-mm-diameter nylon washers on the upper wing surface and a single washer on the lower wing surface. The ends of the nylon pin were melted with a naked flame and flattened into a plug to prevent the washers sliding off. A pin length of 22 mm between washers was found to be adequate, as this prevented the tag from twisting on the pin whilst ensuring that the tag remained proud of the lesser coverts and scapulars. These visual markers could be read up to 0.7 km away using a  $\times 60$  telescope and were especially valuable for identifying individuals in the field without the need for capture. The life span of the markers was limited, since degradation of the nylon washers on the upper wing surface by ultraviolet light caused them to become brittle with age. This was accentuated by plastic fatigue caused by the plastic tag continually flapping in the wind. Consequently, washers failed and tags were lost three to five years after they were fitted, although tag life could be extended by fitting more than one washer. Steel-pinned tags apparently lasted longer.

At the time of fledging (7 to 8 weeks old), the primary, secondary and tail feathers are 'soft-penned' (i.e. feather quills contained blood and were easily damaged) as their development is still incomplete. At about 10 weeks old, however, they become 'hard-penned' (i.e. feather quills contained no blood). At the latter stage, a tail-mounted TW2 Biotrack 20-g radio transmitter was fitted to all the Red Kites released during 1989-93 in southern England using the method described by Kenward (1978). This technique ensured that the transmitter would be shed with the tail feathers during the bird's first moult in June and July in the following year. In northern Scotland, the same method was used during 1989-91; during 1992-93, however, an undertail-mounting technique was employed. This method concealed the TW2 transmitter in the undertail-coverts and involved attaching the transmitter to a 2-cm length of hollow pipe which was inserted over the rachis, pushed down to the base of the tail feather and glued into position. A single aerial was attached to the rachis with glue and dental floss and trimmed to the length of the tail feather.