ENGLISH NATURE

Report Number
451

The Red Kite Reintroduction Programme in England

English Nature Research Reports

working today
for nature tomorrow

English Nature Research Reports

No. 451

The Red Kite Reintroduction Programme in England

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ISSN0967-876X

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Summary

1. This report describes recent work on the red kite reintroduction programme in England, concentrating on the Midlands release project in the period from 1995 to the winter of 2001/02. The results of monitoring and research work, involving released birds and the establishing breeding population, are reported.

2. The red kite reintroduction programme has been carried as a partnership between government agencies, conservation charities and local landowners. The programme has had a high public profile and has played an important role in highlighting key issues currently affecting birds of prey in England. Illegal persecution and secondary poisoning have been identified as significant problems and publicity associated with the programme has been useful in helping to tackle these issues.

3. A total of 70 birds, mainly from central Spain and southern England, were released in the Midlands in 1995-98, using methods established by earlier releases in southern England and northern Scotland. Intensive monitoring was carried out, aided by the fitting of wing-tags and tail-mounted radio-transmitters to each bird before release.

4. Released birds included several rehabilitated individuals from other red kite populations and these made an important contribution to the project in its early stages. Two rehabilitated birds that spent time in captivity as nestlings seemed poorly adapted to life in the wild, probably because they had become used to regular contact with humans.

5. An average of 36% of released birds dispersed away from the Midlands in their first autumn. The proportion of birds that dispersed declined in later years of the project as a breeding population became established. Some birds that remained in the Midlands during their first winter, dispersed in the following spring. A higher proportion of females than males dispersed, leading to an imbalance in the sexes in the Midlands population. Some dispersing birds returned to the Midlands to breed, others recruited into the southern England or Welsh populations. Immigrants to the Midlands population included untagged birds of unknown origin and wing-tagged birds from southern England, Suffolk and Scotland.

6. Based on re-sightings of wing-tagged birds and radio-tracking, a minimum of 58% of birds released in the Midlands survived their first-year and at least 67% of older birds survived from one year to the next. Survival rates were higher for birds that remained in the Midlands where local farmers and gamekeepers recognised that they posed no threat to livestock or gamebirds. Wild-fledged young had slightly higher survival rates than released birds, probably due to lower dispersal rates.

7. A single communal roost area was used by the majority of birds in the Midlands population from early in the project through until at least the 2001/02 winter. This behaviour was very useful when monitoring birds as it ensured a predictable location where birds gathered in large numbers and could be identified by radio-tracking or through reading wing-tags.

8. Attempts were made to locate all breeding pairs in the period 1996-2000. The first breeding attempt was in 1996, the first young were fledged in 1997 and, in 2000, a

minimum of 16 breeding pairs fledged 22 young. The Midlands population increased at a slightly slower rate than the southern England population during the equivalent period. In 2001, of a sample of 11 breeding attempts that were monitored, nine were successful, fledging 25 young. It was estimated from the number of first-year birds attending the winter roost in 2001/02 that about 15 pairs bred in total. It is thought that the lack of increase in breeding pairs between 2000 and 2001 resulted mainly from an imbalance in the sexes among adults in the population. The total population was estimated at about 70 birds based on visits to the main communal roost in winter 2001/02.

9. Monitoring of the breeding population as it became established showed that red kite pairs were highly flexible in their choice of breeding site, using both large and very small woods in a variety of different situations. Most individuals bred for the first time when two years old but a small number of birds remained unpaired at this age and there were several pairs where one or both of the birds were in their first year. The red kite is fairly tolerant of routine human activity within sight of the nest but may be adversely affected by excessive disturbance close to the nest, particularly when incubating eggs or brooding small chicks. It is recommended that forestry operations are not carried out within 400m of an active nest. Midlands pairs averaged 1.7 young per breeding attempt, slightly lower than in southern England or northern Scotland but similar to typical values for continental Europe and much higher than in Wales.

10. The radio-tracking of released birds in their first year showed that individuals were rarely found more than 4-5km away from the communal roost and utilised an average home range of 23km^2. In the breeding season, the majority of records of adults were within 3km of their nest site and females rarely strayed more than 1km from an active nest. Of the 16 breeding pairs found in 2000, 11 were within 5km of the communal winter roost and the others were all within 10km. It is expected that population density will increase substantially before there is a significant increase in breeding range, reflecting what has happened in the Chilterns population.

11. Diet was assessed by studying regurgitated pellets found at roost and nest sites, food remains found at nests and the direct observation of foraging birds. The most important foods were rabbits, rats, small mammals gamebirds, pigeons and corvids but a wide range of different species were taken, confirming the generalist nature of the red kite. The majority of food was taken as carrion but some live prey was also taken, mainly in the breeding season. Many important food sources resulted from human activities including pest control, game rearing, agricultural operations, road kills and the deliberate provision of food by sympathetic landowners. Open habitats were favoured for foraging and monitoring of birds outside the breeding season showed that intensively managed arable farmland and pasture habitats were utilised roughly in proportion to their occurrence in the area.

12. All birds found dead in a reasonably fresh condition were sent for post-mortem and, when poisoning was suspected, for tissue analysis. Radio-tracking allowed many dead birds to be located by project staff and the use of wing-tags increased the likelihood of carcasses being reported by members of the public. The main mortality factors affecting the red kite in England relate to human activities. Illegal poisoning and accidental secondary poisoning by rodenticides are of particular concern. Other

potentially significant mortality factors include shooting, collision with vehicles and electrocution by powerlines.

13. As a highly adaptable, generalist species, the red kite should be able to thrive in most areas of lowland England provided that the threat from persecution and secondary poisoning can be managed. Despite the suitability of the landscape, the red kite has been very slow to spread from the release areas. This reflects the bird's highly social nature, strong natal philopatry and the high population densities that can be accommodated close to the release sites. Further release projects may be useful in increasing the rate at which suitable areas are recolonised.

1. Introduction

The red kite was formerly one of our most widespread and familiar birds of prey but became extinct in England and Scotland by the end of the 19th century as a result of human persecution. Only a small number of pairs survived in remote parts of central Wales where levels of persecution were lower. By the mid-1980s, the Welsh population had slowly increased to about 40 breeding pairs but showed no signs of spreading into unoccupied but suitable lowland habitats outside Wales. The damp, cool climate and unproductive landscape meant that breeding success was low and the population was increasing in numbers and range only gradually.

In the late 1980s, the red kite was one of only three British birds considered to be globally threatened and was therefore one of the highest priorities for conservation action. A group of conservation organisations, including the Nature Conservancy Council (now English Nature, Scottish Natural Heritage and the Countryside Council for Wales) and RSPB decided that, in view of the slow rate of spread of the Welsh population, action should be taken to try to restore the red kite to more suitable lowland countryside in England and Scotland. An experimental reintroduction programme was initiated in 1989 after careful assessment of the proposals against the internationally agreed World Conservation Union (IUCN) guidelines for reintroduction (Green 1979; updated by IUCN 1995). Young red kites were taken mainly from nests in Spain and Sweden and released at sites in the Chilterns of southern England and the Black Isle, northern Scotland in 1989-1994. The background to the reintroduction programme, including the methods used and the results of the first phase of releases in the Chilterns and on the Black Isle have already been published (Evans & Pienkowski 1991; Evans *et al* 1997; Evans *et al* 1999).

Following the establishment of self-sustaining breeding populations in both initial release areas, releases commenced at further sites in order to increase the rate at which suitable areas throughout Britain were recolonised. Releases began in the east Midlands in 1995, central Scotland in 1996, Yorkshire in 1999, and southern Scotland in 2001.

This report concentrates on the work carried out in England between 1995 and the winter of 2001/02, focussing on efforts to establish a second English population of red kites in the east Midlands, a joint English Nature/RSPB project, supported by Forest Enterprise. The methods for successfully reintroducing red kites had already been established by earlier releases, and so there was more emphasis on research during work in the east Midlands. This phase of the reintroduction programme was seen as an ideal opportunity to learn more about the ecology of the red kite in lowland England, particularly with regard to the main threats faced by the species and the potential for population increase and spread to new areas. Some of the results of this research have already been published (e.g. Carter & Burn 2000; Carter & Grice 2000). Full details are, nevertheless, provided in this report and together with the ongoing monitoring of the Chilterns population, they provide a sound basis for assessing the future prospects of the red kite in England.

In 1999, the first birds were released at a third English site, on the Harewood Estate in Yorkshire. This project is still in its early stages and it is likely to be some time before those involved are able to produce a detailed appraisal of work in this area.

2. Project management

The Midlands project was carried out and funded by English Nature (as part of its Species Recovery Programme) and the RSPB with support from Forest Enterprise. The two release sites were situated within Forest Enterprise woodland and Forest Enterprise staff provided considerable assistance with collecting the young red kites, maintaining them in captivity and monitoring them after release.

The project was overseen by an England Project Steering Group, with representatives from the three main organisations involved. In the early stages, this group met regularly to discuss progress and plan the next stage of the project. After the first three years the England group ceased to meet but those involved in the project continued to attend the annual meeting of the UK Red Kite Coordination Group. This group was established in 1986 when plans to reintroduce the red kite were first being considered and is responsible for overseeing work on the species throughout the UK.

Work in the Midlands was coordinated by a Project Officer employed full-time from 1995 to 2001 and responsible to a Project Manager, both of whom were based at English Nature's Peterborough headquarters. Monitoring of the established population in the Chilterns was coordinated by an English Nature/RSPB funded Project Officer working full time in the breeding season and part time for the rest of the year. In 1998 the Southern England Kite Group (SEKG) was set up to improve the coordination of monitoring work in the Chilterns. The group was initially made up of the Project Officer and two volunteer fieldworkers.

3. Publicity – the red kite as a flagship

The re-introduction programme has received considerable publicity since work began in 1989 and continues to do so more than ten years after the first birds were released. In the Midlands, much of the attention focussed on the release of the birds from their aviaries in each year from 1995 to 1998. This event proved highly popular with local and national media and attracted large turnouts in each of the four years. Coverage was almost entirely positive, portraying the project as a successful partnership between conservation organisations and the local community, with all parties working together to restore one of our most attractive native species.

In 1997, BBC East Midlands followed a year's work on the Midlands project including the collection of young from central Spain, captive rearing and release, and monitoring of breeding pairs established as a result of earlier releases. The coverage was broadcast on the regional news during five consecutive days and shorter versions were screened on various other local and national stations.

Since 1998, when the last birds were released in the Midlands, much of the positive publicity has been associated with an annual press release providing the results of the latest breeding season's survey work. Coverage was particularly good following the press release of the results of the first full UK breeding survey in 2000, coordinated by English Nature, Scottish Natural Heritage, RSPB and the Welsh Kite Trust.

In 2001 a project known as 'Red Kites @ Rockingham' was set up jointly with Forest Enterprise and the RSPB. This involved installing a CCTV camera at an active nest site within woodland close to Forest Enterprise's east Midlands office. Live pictures from the nest could be viewed in a makeshift visitor centre and on the websites of English Nature and RSPB. The project proved to be extremely popular and attracted a steady stream of visitors to the centre during the period when young were in the nest. The red kite section of English Nature's website was the most popular part of the site during the first few weeks when live pictures could be viewed, receiving over 3,000 visits in July alone. The project will be repeated in 2002 when there will also be a programme of red kite walks led by project staff and it is hoped to establish a small feeding platform where red kites can be viewed from a hide.

One of the most valued aspects of the red kite programme has been its role in highlighting the main threats currently faced by birds of prey in England. The red kite is particularly susceptible to illegal persecution and accidental secondary poisoning by rodenticides (Carter & Grice 2000; Carter & Burn 2000) and, as a result of the bird's popularity and awareness of the re-introduction project, deaths from these causes have attracted considerable media attention. It is hoped that the public outcry resulting from examples of illegal killing, together with media coverage of action taken to identify those responsible, will have a deterrent effect on others considering similar activities. Where deaths have resulted from the legal use of poison, attempts have been made to publicise alternative methods of pest control and practices for minimising risk where potentially harmful products are used. Advice has been included within the annual Midlands project newsletter, specific advice notes and through press releases and media interviews.

4. Release methods and monitoring

Work in the east Midlands was based on methods that had already been successful in re-establishing red kites in southern England and northern Scotland, as documented by Evans *et al* (1997).

4.1 Selection of release site

Following work in the first two release areas it was apparent that the red kite would do well in most areas of lowland Britain, provided that the basic requirements of woodland for nesting and roosting, and open areas for foraging were met. The Rockingham Forest area in Northamptonshire in the east Midlands has a relatively high proportion of woodland (approximately 15%) with a mixture of improved grassland (20%) and arable land (60%) making up most of the unwooded area (Carter & Grice 2000). Although most of the farmland is intensively managed, game shooting is carried out on many local estates and management here is geared towards providing sufficient suitable habitat for gamebirds. This improves conditions for a range of wildlife and helps to ensure a wide prey base for the red kite.

Rockingham Forest is approximately 100km from the Chilterns release area. This was thought to be an ideal distance as it was hoped that, within a reasonable period of time, established populations centred on the two areas would begin to link together forming one larger, and therefore less vulnerable, population.

Two aviaries, each divided into three separate compartments, were built 5km apart, concealed within large blocks of woodland but within 1km of the woodland edge. The aviaries were constructed according to the design used in the Chilterns (Evans, Pienkowski & Dennis 1991) but with a minor modification. Instead of part of the front of each compartment being made from wire mesh, which allowed the birds to see their surroundings, all sides were constructed entirely from wood. In the Chilterns it was found that birds within the aviaries became alarmed if they could see someone approaching them and risked damaging themselves by flying against the wire mesh. It had been thought that it was important for the birds to be able to see their surroundings so that they would imprint on the local area before being released. However, as is the case when fledging naturally in the wild, the young birds imprint on the area once they have been released but whilst they are still dependent on food provided at or close to the aviary. Each compartment contained a covered nest platform, where up to four young were placed on arrival, and several perches that were used once the birds could fly.

4.2 Translocation and care in captivity

The majority of the 70 red kites released in the Midlands were collected as nestling of 4-6 weeks old. At this age they are fully-feathered and no longer require brooding by the adult birds. They are also capable of feeding unaided from chopped carcasses, which helps keep human contact to a minimum when provisioning the birds with food. In 1995, 1996 and 1997 young were collected from nests within high-density red kite populations in the provinces of Segovia and Salamanca in Castilla y León, central Spain. In 1997, birds were also taken from nests in the Chilterns and in 1998 all birds for release in the Midlands were taken from Chilterns nests.

The total of 70 birds includes four rehabilitated individuals and a single chick from Wales, collected in 1996 as part of a scheme, administered by the Welsh Kite Trust, for rescuing eggs from nests known to be the target of egg collectors. The bird was hatched and reared in captivity, using a Buzzard as a surrogate mother, by Dr Nick Fox, before being taken to the release site when about six weeks old. Birds rescued in this way are normally returned to Welsh nests but where this was not possible there was agreement that they could be supplied to the reintroduction project in England.

Table 1: Red kites released in the Midlands

Year (number of birds)	Origin and age of birds
1995 (11)	10 Spanish young (9 from Segovia, 1 from Salamanca) One-year old rehabilitated bird from Chilterns
1996 (18)	15 Spanish young (10 from Segovia, 5 from Salamanca) One-year old rehabilitated bird from Chilterns Rehabilitated Welsh adult Bird from Welsh nest hatched and reared in captivity
1997 (20)	10 Spanish young (all from Segovia) 10 Chilterns young
1998 (21)	21 Chilterns young (including one found injured in nest that spent several weeks receiving veterinary care in captivity before release)

Donor nests were always left with at least a single chick so that the breeding pair remained at the site with a good chance of rearing at least one chick to fledging. Only on one occasion were all chicks removed from a nest in Spain because the nest wood was in the process of being felled and so the nest stood little chance of survival. It had been thought that the chick(s) remaining in donor nests had an improved chance of survival as, if food were in short supply, their share would increase following the removal of competing siblings (Carter *et al* 1999). However, recent evidence from collecting young in the Chilterns suggests that survival rates of wing-tagged birds remaining in donor nests are lower than for birds from nests that are not manipulated (Nigel Snell & Peter Stevens in litt.). It is not known why this is the case as donor nests are certainly not abandoned by the adults. It is possible that the chick(s) left in donor nests interpret the disappearance of their siblings as predation and therefore try to leave the nest as quickly as possible, before they are able to fly strongly. This could increase the risk of accidents and fledglings that end up on the ground become vulnerable to predators such as foxes. More information is required to confirm these findings and establish the extent to which survival rates are reduced.

Young birds imported from Spain were required by MAFF (now DEFRA) to spend a minimum of five weeks in quarantine. This period was served within the release aviary. Most birds in fact spent about 6-8 weeks in captivity, taking them several weeks beyond their natural fledging age. This was to allow the tail feathers to complete their growth and become fully hardened so that tail-mounted radio-transmitters could be attached. It was also felt that there might be an advantage in releasing birds slightly beyond their normal fledging age in order to allow their flying abilities to improve before release. In the wild, young may leave a nest before they are able to fly strongly, probably due to the higher risk of predation whilst they remain on the nest.

A surplus of food was provided daily using a small feeding hatch directly above the nest platform in order to minimise human contact. Animal carcasses were chopped finely when the young first arrived but could be given in large pieces after a few weeks for the young to tear apart for themselves. A varied diet was made available, relying heavily on pest species controlled by local foresters, including rabbits, grey squirrels, muntjac, fallow deer, corvids and woodpigeon. Red kites, as with most raptors, derive all the water they need from their food and so a separate water supply was not required.

Once the young reached fledging age at about 7-8 weeks they spent most of their time resting on perches provided within the aviary. There was sufficient room within each compartment for birds to fly between perches and the nest platform in order to build strength in their flight muscles before release. Veterinary checks were carried out by the Zoological Society of London's Institute of Zoology (IoZ) to make sure that all birds were fit enough for release and a blood sample was taken from each bird so that its sex could be determined by DNA analysis. On the few occasions where there were doubts as to whether a bird was fully fit it was given the appropriate veterinary treatment and held back from release to allow further tests to be carried out. There were no deaths in captivity and it was ultimately possible to release all birds that were brought to the release aviaries.

Releases were carried out by simply removing one of the two wooden front panels from each of the aviary compartments and allowing the birds to fly free. Food was provided on, or close to, the aviaries for about three weeks, by which time the released birds had clearly adapted to finding their own food sources and rarely returned to the release site. Some individuals stopped returning to the aviary for food after only a few days. Others made use of this food supply for the full three weeks, although became gradually less dependent upon it.

4.3 Post-release monitoring

As laid down by internationally agreed World Conservation Union (IUCN) guidelines, a well-planned reintroduction project should include a programme of monitoring so that the success, or otherwise, of releases can be assessed and any potential problems identified at an early stage. In order to aid monitoring, each young red kite was fitted with coloured plastic wing-tags and a radio-transmitter before being released. The plastic tags were colour coded for different years and had a letter, number or symbol that allowed each individual bird to be identified. In good light, it was possible to read tags at up to 800m away using a high-powered telescope. Wing-tags included a contact telephone number on the reverse, which increased the chance that birds found dead by members of the public would be reported. The nylon thread used to attach tags to the wings degrades slowly in daylight, becoming brittle and vulnerable to breaking. As a result, tags were lost after an average of 3-4 years.

Tail-mounted radio-transmitters weighing approximately 20g were supplied by Biotrack Ltd. Their effective range varied depending on environmental conditions and the behaviour of the bird. It was often over 10km for a flying bird when using the radio receiver at a hilltop vantage point but could be less than 2km for a bird on the ground with no direct line of sight between it and the receiver. Each transmitter included a mercury tilt-switch that varied the pulse rate of the signal received depending on the activity of the bird (e.g. flying or perched). A sustained lack of variation in the signal suggested that the bird was dead and it was then possible to locate the carcass by radio-tracking so that a post-mortem could be carried out. Tail-mounted radios remained attached to the bird for about one year and were lost when the two central tail feathers were dropped as part of the annual moult. In recent years a small

number of nestlings in the Midlands have been fitted with harness-mounted radio transmitters. These remain attached to the birds permanently and have a battery life of 2-3 years, allowing birds to be radio-tracked into adulthood.

5. Rehabilitation

Four rehabilitated red kites were released in the Midlands in 1995-1998 as part of the reintroduction project. Three originated from the established Chilterns population and a fourth was confiscated from captivity in Wales during a police investigation. Brief case histories are presented below:

Bird 1: This male bird was released as a juvenile in the Chilterns in 1994 but was subsequently found with shotgun wounds and was taken into care at the Institute of Zoology. It was treated and allowed to recover in captivity for about two months before being taken to the Midlands and released when 15 months old in August 1995. Despite still having more than 10 pieces of lead shot embedded in its tissues it fared well in the wild and paired with a first-year female in 1996. It bred unsuccessfully in 1996 but remained paired and bred successfully in several years up until at least 2000.

Bird 2: This was another first-year bird found with shotgun wounds in the Chilterns. After several weeks of treatment at the IoZ it was released in the Midlands in September 1996. Radio-tracking revealed that it quickly dispersed, being found subsequently in north-west Essex where it was last recorded in December 1996.

Bird 3: The police in Wales confiscated this adult of unknown age from captivity in 1996. It is likely that it was illegally taken from the wild as a nestling and so probably had no previous experience of living in the wild. It was released in the Midlands in November 1996 but was found emaciated in the release area in January 1997 and, despite treatment, died soon after being taken into care.

Bird 4: This bird was found as a four-week-old nestling in the Chilterns in 1998. It had plastic tied tightly around one leg and as its chances of surviving in the wild were thought to be slim it was taken into captivity at a private wildlife hospital for treatment. The plastic was removed and after three weeks recuperation it was released in the Midlands in July. It quickly dispersed away from the release area and was not seen again until the autumn of the following year when it was recorded in Wiltshire.

From post-release monitoring, it appeared that the two birds which had spent time in captivity as nestlings were less well adapted to life in the wild than birds released by the usual methods where contact with humans was kept to an absolute minimum. Bird 3 was reluctant to spend time searching for food and although it was physically able to fly well, it spent long periods perched up in trees, allowing itself to be approached closely by fieldworkers. It survived several months and so was obviously managing to find some food but it gradually lost condition until it eventually became too weak to fly. Bird 4 spent only three weeks in care as a nestling but became used to being handled by staff at a private wildlife hospital and it too appeared reluctant to fly large distances when first released. However, this bird did subsequently disperse away from the Midlands and was known to be alive by the following autumn so it clearly did manage to cope with life in the wild. The behaviour of these birds confirms the need to keep human contact to a minimum when collecting nestlings for later release.

Two birds (1 and 2) were treated in captivity when about one year old at the IoZ where staff were aware of the need to minimise human contact. Both behaved more naturally when released, flying strongly and quickly learning to locate food for themselves. Bird 2 dispersed but survived for at least three months in a new area before contact was lost. Bird 1 survived in the release area for at least five years, breeding successfully in at least three years and making an extremely valuable contribution to the early stages of the project.

6. Dispersal patterns

The red kite is migratory in parts of its range, notably in central Europe, where the majority of the breeding population moves south to winter in Iberia. In Wales, the red kite is largely resident although adults sometimes undertake local movements between breeding and wintering sites and a proportion of young birds disperse out of Wales during their first year (Cross & Davis 1998).

As all birds released in the Midlands were closely monitored by radio-tacking in their first year, a comprehensive picture of dispersal patterns was built up during the course of the project. Each year, a varying proportion of released birds moved away from the release area, either in their first autumn, when radio-tracking effort was high, or, in the spring of the following year, when monitoring was less intensive and the record of dispersing birds is incomplete. Dispersal is defined here as a movement of at least 25km from the release site, although in the majority of cases dispersal distances were far greater. All figures for dispersal are minimum values as some birds may have left the area for a short period without being detected. Radio transmitters lasted for only about one year and subsequent movements were often impossible to detect.

6.1 The influence of population size on dispersal

Table 2 shows the proportion of birds that dispersed in their first autumn during the project. The majority of dispersers moved away in late July or August, within a few weeks of being released. A small number remained in the release area until September or even early October before dispersing. All the individuals present in the Midlands in late October remained in the area during their first winter.

Table 2: Autumn dispersal of released red kites in the Midlands

Year	Number of birds released[1]	Number of birds dispersing (%)	Population size (territorial pairs)
1995	10	6 (60)	0
1996	16	6 (37.5)	1
1997	20	9 (45)	5
1998	20	3 (15)	8
Total	66	24 (36)	

[1] Excluding 4 rehabilitated birds

In each of the first three years of the project, between 37.5 and 60% of all released birds dispersed in their first autumn. In the final year of the project, when a population was well established in the area, only 15% of the 20 released birds dispersed. This pattern has been repeated in the other release areas in England and Scotland (Evans *et al* 1999) and is thought to be the result of the highly social nature of the species. If birds are released into an area with no, or very few, red kites then a relatively high proportion disperse. But once the nucleus of a population becomes established, a much higher proportion of birds tend to remain in the area following release. This pattern means that it is sensible to release birds in large groups during the initial stages of a project. If only small numbers of birds are released into vacant habitat then there is a high risk that many, or all, will be lost as a result of dispersal. To minimise losses it is suggested that at least 20 birds should be released in the first year of a project.

The records for birds dispersing in the spring are incomplete as radio-tracking was less intensive at this time of year and some radio-transmitters were lost by late spring/summer due to moult of the central tail feathers. Nevertheless, of 42 released birds that remained in the Midlands during their first winter, a minimum of nine dispersed in the following spring, three in April, five in May and one in late May/early June. April and May were also the peak months for spring dispersal of wild-fledged birds.

6.2 The influence of sex on dispersal

Of the total of 66 birds released in the Midlands (excluding the four rehabilitated birds), analysis of DNA in blood samples revealed that 35 were female, 29 male and two were not sexed. Although the sample size is relatively small and the difference is not statistically significant, a higher proportion of females than males dispersed away from the release area. In all, 21 out of 35 females (60%) and 11 out of 29 males (38%) dispersed more than 25km away from the release site in either their first autumn or in the following spring. Most records were confirmed by reading wing-tags or from the radio-tracking of birds away from the release area. Five records (3 females and 2 males) were based on the sudden disappearance of a radio-tagged bird from the release area in the autumn and these birds were not subsequently relocated.

As a result of differences in dispersal patterns between the sexes, the Midlands population now has an excess of adult males, despite the release of more females than males. This has led to some adult males either not breeding or pairing up with first-year females where the chances of successful breeding are reduced. A similar sex bias in dispersal patterns has been found with releases in other areas (Evans *et al* 1999). This pattern is typical for many birds of prey where it is the male that is responsible for setting up and holding a breeding territory. In this situation, males may increase their chances of successfully establishing a territory and attracting a female if they remain in one area, becoming as familiar as possible with the locality and its most productive foraging areas. Females, with no such responsibilities, have more time to explore further afield, perhaps in search of breeding opportunities in other areas.

The sex bias in dispersal patterns means that, ideally, more females than males should be released, in order to have the best chance of establishing a breeding population with an unbiased sex ratio. However, in the early years of a project, releasing an excess of males may be desirable in order to establish a core population, as males are less likely to disperse away from the area and be lost. A higher proportion of females could then be released in later years. In the Midlands, the results of the sexing from blood samples was not known until after birds had been released and no attempt was made to correct for the eventual imbalance in the sexes.

6.3 Dispersal direction and distance

Monitoring work provided a good indication of the number of released birds that dispersed away from the Midlands, but an incomplete record of the movements that they made. Some individuals, for example, were known to have left the Midlands when the signal from their radio-transmitter became faint before disappearing completely, but were not located subsequently. Other birds were located away from the Midlands but may then have made further movements that were not detected.

Figure 1 shows all records of released individuals positively identified from radio-tracking or wing-tags more than 25km away from their release site. In most cases, each symbol represents a single bird at the furthest location that it was recorded away from the Midlands. In a few cases, where an individual was recorded at locations more than 50km apart, each of these locations is shown by a symbol.

Figure 1: Records of red kites that dispersed away from the Midlands release area

Dispersal has taken place in all directions in a seemingly random pattern. Only a single bird moved more than 100km in a northerly direction and this may reflect either a genuine reluctance to disperse far in this direction or, possibly, the reduced likelihood of birds being reported from less densely populated areas in the north of England. The clusters of records from central Wales and the Chilterns involve birds that have joined up with red kites from the established populations in these areas, demonstrating the social nature of the species.

6.4 The fate of dispersing birds

The figures below show the fate of 48 birds that were known to have dispersed away from the Midlands in their first year.

Released birds - 32 individuals were known to have dispersed

Found dead away from Midlands in first year:	4
Still away from Midlands by second winter:	10
Returned to Midlands:	7
Fate unknown:	11

Wild-fledged birds - 16 individuals were known to have dispersed

Found dead in first-year:	0
Still away from Midlands by second winter:	5
Returned to Midlands:	4
Fate unknown:	7

Of the 15 birds that remained away from the Midlands, 13 joined up with established red kite populations in the Chilterns or central Wales, of which at least three attempted to breed (one in Wales, two in the Chilterns). Others probably also bred in these areas but this was not confirmed by positively identifying them at a nest site. The high proportion of dispersing birds that were found in the Chilterns or Wales reflects both the highly social nature of the red kite and the concentration of survey effort in these areas. The red kite shows a high degree of natal philopatry and young birds often end up breeding close to the site where they themselves were reared (or released). This applies not only to birds than remain in the natal (or release) area all their life but also to a proportion of dispersing birds that return to the natal area for their first breeding attempt. Eleven of the dispersing birds returned to the Midlands, of which at least five made subsequent breeding attempts. Others may also have done so without being identified at a nest site.

Monitoring showed that few birds made long-distance movements after their first year and the location where a bird was found in its second winter was almost inevitably where it remained to breed. However, there were a small number of exceptions to this rule. The following are examples of the movements made by a selection of the more adventurous Midlands birds:

Grey F (female), released July 1995: This bird spent only about two weeks in the Midlands before dispersing to north Wales where it spent its first winter on the edge of Snowdonia National Park. The last record from north Wales was in late March 1996 and it was next seen in the Chilterns red kite area in September 1996. It was still present in the Chilterns in April 1998 and, given its age, has almost certainly bred in this area.

White 7 (female), released July 1996: This bird also left the Midlands soon after release and was next seen at the red kite feeding centre at Gigrin Farm, central Wales in October and again, later in the same winter, in December and January. It made a brief return to the Midlands in April 1997 before heading back to mid-Wales where it was found dead under powerlines in March 1998.

Red 1 (female), released July 1997: By early August this individual had dispersed away from the Midlands and was subsequently found in the Chilterns red kite area in December of the same year. It remained in the Chilterns until at least March 1999 before being seen back in the Midlands in August 1999. It paired up and bred in the Midlands, unsuccessfully in 2000 and then successfully in 2001.

WhiteBlack B (male), fledged June 1999: Unlike the previous examples, this bird spent its first winter in the Midlands before dispersing to the Chilterns in early May 2000. It remained in the Chilterns until August 2000 and then made a total of at least six separate movements between the Chilterns and Midlands red kite areas in the period August 2000 to November 2001. It finally settled in the Midlands for the 2001/02 winter where it was seen regularly at the communal roost.

6.5 Immigration into the Midlands population

Since the start of the project in 1995, eight immigrant red kites have been recorded in the Midlands, where they have joined birds in the Midlands population either temporarily, or as permanent recruits into the population. Two untagged adult birds joined released birds early on in the project. They were first seen together at the main communal roost in August 1996 and remained over the next few years, breeding successfully on several occasions. It was known that they were immigrants as, at this stage of the project, all the Midlands released birds still had their wing-tags.

Three wild-fledged birds from the Chilterns and one from Suffolk have been seen in the Midlands during their first year. Two were first recorded in the Midlands in their first autumn and two were first seen in their second autumn, although they may well have arrived in the summer but gone undetected until the winter roost formed. Two of the four birds recruited into the population, breeding for the first time when two years old having paired up with Midlands birds.

Two wild-fledged Scottish birds have visited the Midlands. The first fledged in northern Scotland in 1995. It was then recorded in north Yorkshire, on route to the Midlands where it was seen several times during November and December 1995. It was later recorded at a communal roost in the Chilterns before returning to northern Scotland to breed. The second bird fledged from a nest in central Scotland in 1998. It was seen regularly at the Midlands communal roost during the 1998/99 winter but there were no sightings after February 1999.

Table 3: Immigrant red kites in the Midlands

Area of origin (date of fledging)	Dates in Midlands	Wing-tags	Notes
North Scotland (1995)	Nov-Dec 1995	Blue G	Also seen in north Yorkshire and Chilterns before returning to north Scotland to breed
Unknown	First seen May 1996 – settled in Midlands	None	Known immigrant as all other Midlands birds had wing-tags
Unknown	First seen Aug 1996 – settled in Midlands	None	Paired with bird above – bred several years running
Chilterns (1996)	Aug-early Sept 1996	Yellow 17	Associating with Midlands birds released in late summer; returned to Chilterns by mid-Sept
Suffolk (1996)	Oct 1996 – Feb 1997	Yellow '?'	One of two young fledged by isolated breeding pair in Suffolk. Seen in Norfolk in Nov 1997 – Feb 1998 with a second red kite
Chilterns (1997)	First seen Sept 1998	Black 17	Paired with Midlands bird and bred in 1999 and 2000; still present in winter 2001/02
Chilterns (1997)	First seen Sept 1998	Black 28	Paired with Midlands bird and bred in 1999 and 2000
Central Scotland (1998)	Nov 1998 – Feb 1999	Red '3 dots'	

7. Survival rates

7.1 Released red kites

Survival rates were calculated for birds in their first, second and third years based on radio-tracking (first-year only) and re-sightings of wing-tagged birds, using the arbitrary date of 1st July each year (table 4). It was impossible to determine reliable survival rates for older birds due to small sample sizes and the relatively high rate of wing-tag loss after three years. All the calculated survival rates are minimum values for the follow reasons:

(i) Figures are based on the number of birds known to be alive in each period and birds that dispersed away from the release area may have gone undetected.

(ii) Although most wing-tags were lost after three years or more, premature loss of tags in earlier years may have occurred in a small number of cases, resulting in surviving birds going undetected. This is likely to affect the figures for second and third-year birds.

Table 4: Survival rates for red kites released in the Midlands

Year class	Proportion surviving (sample size)
1st year	58% (n=66)
2nd year	66% (n=38)
3rd year	67% (n=18)
Midlands 1st year[1]	100% (n=43)

[1]See text below for explanation

The main reason for the lower survival rates for birds in their first year is because a far higher proportion of birds in this age class dispersed away from the release area than was the case with older birds. This resulted in lower figures for survival partly because birds that dispersed were more likely to go undetected and partly because dispersing birds became more vulnerable to human persecution than those which remained in the release area. Landowners, farmers and gamekeepers in the release area quickly became familiar with the local red kites and, as a result of their own observations and contact with project workers, accepted that they posed no threat to livestock or gamebirds. Landowners in other areas may view the sudden appearance of a large and unfamiliar bird of prey with suspicion and, in some cases, resort to illegal persecution. In order to determine the survival rate for first-year red kites that did not disperse, birds that remained in the release area for their first winter (October to March), between the usual autumn and spring dispersal periods, were considered ('Midlands 1st year' in table 4). In all, 43 of the 66 released birds were still present in the Midlands by October of their first year, and remarkably, all 43 survived their first six months in the wild.

A further indication of the increased vulnerability of dispersing birds is provided by figures on known mortalities of released birds. Up to March 2001, 15 of the 66 released birds had been found dead. Of these, only five were found within the Midlands core area (within 25km of the release site), despite the concentration of birds that remained in the Midlands and the far more intensive monitoring of birds in the release area.

7.2 Wild-fledged red kites

Monitoring of wild-fledged birds has been less intensive than for released birds and only a small proportion of individuals were fitted with radio-transmitters. A large number were, however, fitted with wing-tags and minimum survival rates were calculated from re-sightings, mainly at the communal winter roost. Regular visits to the roost ensured that wing-tagged birds present in the area were recorded regularly. Table 5 shows that the minimum survival rates for wild-fledged birds in their first and second year were similar, though slightly higher, than for released birds. It is thought that the higher survival rates result from the lower proportion of wild-fledged than released birds that dispersed away from the Midlands.

Table 5: Survival rates for wild-fledged red kites in the Midlands

Year class	Proportion surviving (sample size)
1st year	63% (n=46)
2nd year	88% (n=17)

8. Communal winter roosting behaviour

From very early on in the project, through until the 2001/02 winter, the same communal roost area was used repeatedly by the majority of birds in the Midlands population. The site comprised a large area of mainly deciduous woodland 8-10km away from the two release sites. Each afternoon in the period September to March, birds returned to roost in trees within the same area of approximately 2km^2. The precise groups of trees used for roosting varied but the roost always formed within the same area and the same blocks of trees were often used each night over a period of several weeks or more (see Carter 2001 for a full description of roosting and pre-roosting behaviour).

Communal roosting behaviour proved to be an extremely useful aid to population monitoring as it ensured a predictable location where birds could be studied throughout the winter. Pre-roosting birds often perched on the edge of woodland blocks or in hedgeline trees and it was relatively easy to read wing-tags or check the attendance patterns of birds through radio-tracking. This work established that birds in their first and second year, yet to make a breeding attempt, almost invariably attended the roost each night and were only absent on very rare occasions. Adult birds also regularly attended but those in established pairs also, at times, roosted elsewhere, most likely on their breeding territory. Adult pairs with breeding sites some distance away from the roost were less likely to attend regularly than those with sites close by.

It is thought that the main benefit of communal roosting is in concentrating birds in a small area so that social foraging is facilitated (see section 12.6). Red kites are thought to improve their chances of finding food by foraging in loose groups and communal roosting ensures that such groups can form readily at the beginning of each day. Breeding adults are more experienced and also have a thorough knowledge of the area around their nest site and so may not need to rely on communal roosting to the same extent as younger birds (Heredia, Alonso & Hiraldo 1991). Communal roosts also provide an ideal opportunity for birds to interact with each other and may play a role in facilitating social behaviour important in forming pair bonds. Aerial displays were regularly seen during pre-roost gatherings in the Midlands involving two or more birds chasing, play-fighting with outstretched talons and using exaggerated, slow-flapping flight.

9. Population establishment and current status

9.1 Breeding pairs 1995-2000

Table 6 provides summary details for the early stages of the Midlands reintroduction project as a breeding population became established. The first breeding attempt was in 1996 with the first successful breeding in the following year. Since then, the population has increased to a minimum of 16 breeding pairs in 2000. There was an increase in the number of breeding pairs and fledged young in every year with the exception of 1998. In this year, six well-grown chicks were found dead in three separate nests, due to unknown causes, and only three young fledged successfully.

Table 6: The Midlands red kite population, 1995-2000

	1995	**1996**	**1997**	**1998**	**1999**	**2000**
Birds released	11	18	20	21		
Territorial pairs		1	5	8	10	16
Breeding (egg-laying) pairs		1	4	4	7	16
Successful pairs			3	2	6	10
Young fledged			8	3	16	22
Productivity (fledged young/breeding pair)			2.0	0.8	2.3	1.4

In the period 1996-2000 inclusive, an attempt was made to locate every breeding pair in the Midlands population and wing-tags were fitted to all the nestlings. This was relatively easy in the early years of the project due to the small number of birds in the area, as considerable effort could be put into locating each pair. In 1999 and 2000, when the population had increased, it was more difficult to find all of the breeding pairs. In both these years a small number of young birds without wing-tags were seen in the area in the autumn and winter following the breeding season. It is likely that these birds were from local nests that were not located during the breeding season (almost all young from known nests were fitted with wing-tags). The breeding figures for 1999 and 2000 must therefore be regarded as slight underestimates of the true population.

Table 7 gives summary figures for the Chilterns population from the year of the first releases in 1989 until 2000, for comparison with the Midlands. The Midlands population has increased at a slightly slower rate than was the case in the Chilterns during the equivalent period. This probably reflects a combination of factors, including slightly higher breeding productivity and survival rates in the Chilterns and a greater loss of birds from the Midlands due to dispersal and recruitment into the larger Chilterns population.

Table 7: The Chilterns red kite population, 1989-2000

	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000
Birds released	5	13	15	20	20	20						
Territorial pairs[1]			2	7	12	22	26	37	54	78	86	126
Breeding pairs[1]			2	4	9	20	24	35	52	71	75	112
Successful pairs[1]				4	8	17	22	33	46	65	71	94
Young fledged[1]				9	14	37	55	80	100	143	155	202
Young removed									10	21	23	19
Productivity (fledged young/breeding pair)				2.2	1.6	1.8	2.3	2.3	1.9	2.0	2.1	1.8

[1] Figures in later years will be underestimates as not all pairs were located

9.2 Estimating the 2001 breeding population

In 2001, the amount of time devoted to fieldwork was insufficient to locate all the breeding pairs in the Midlands population. This was due partly to restrictions in place during the foot and mouth outbreak and partly to an acceptance that the population had become self-sustaining and intensive monitoring was no longer necessary. Limited survey work was undertaken and a total of 11 breeding pairs were located and monitored during the breeding season. Of these, nine were successful, rearing a total of 25 young, all of which were fitted with wing-tags.

During the 2001/02 winter an estimate of the total number of breeding pairs in the Midlands in 2001 was derived from the ratio of untagged to tagged first-year birds (which remain separable from adults due to plumage differences during their first winter) present at the main communal roost site. Regular visits were made to the roost and each time a first-year bird was seen clearly, either perched or in flight, the presence or absence of wing-tags was recorded. In all, 138 records involved 101 sightings of tagged first-year birds and 37 sightings of untagged first-years. Based on the knowledge that 25 young red kites were fitted with wing-tags in the 2001 breeding season, the ratio 37:101 was used to reach an estimate for the number of young that fledged from nests that were not located (25 * 37/101 = 9.2). Using the average productivity for breeding pairs monitored in 2001 (2.3 young per breeding pair) it was estimated that four pairs were present but not located in 2001 (9.2/2.3 = 4.0). The total population in 2001 is therefore estimated at 15 breeding pairs (11 located, plus 4 estimated from the calculations above), similar to the figure for the previous year.

The ‘ratio method’ for estimating the numbers of untagged first-years relies on two main assumptions that are dealt with below:

(i) All first-year birds in the population regularly attend the communal roost site.

It is known from sightings of wing-tagged birds that individuals remaining in the Midlands population during their first year use the roost regularly. Individuals with radio-transmitters were almost invariably present at the roost site when checked at dusk, including individuals fledged from outlying nests, 5km or more away from the roost.

(ii) Immigration into the Midlands population is limited.

For this method to produce a reliable estimate it is assumed that the untagged first-years seen at the roost are from local nests rather than immigrants from another population. Over the last few years large numbers of young from the two nearest populations in the Chilterns and Wales have been fitted with wing-tags and colour-rings respectively. During the previous five winters only three of these birds, all from the Chilterns, have been recorded at the Midlands roost site. This demonstrates that immigration levels are very low and that all, or almost all, of the first-year birds seen at the roost are likely to have originated from the local, Midlands population.

One of the main reasons for the lack of increase in the number of breeding pairs in 2001 is thought to be due to a shortage of females in the adult population. In 2000 and 2001 a number of adult males either paired up with first-year females or remained unpaired. It is hoped that this imbalance in the sex ratio will even out in the coming years as the population continues to expand.

9.3 Total population estimate

During 2001/02, a total of 22 visits were made to the main communal roost in order to collect data to estimate the total number of red kites in the Midlands population. Wing-tags were read as birds perched in the area of the roost and, over the course of the winter, it was possible to establish the number of tagged birds from each year-group that were present. Days with little or no wind provided the best conditions for reading tags as birds tended to perch more during the pre-roost period. On windy days birds spent more time flying in groups above the roost area and few tags were read.

Untagged birds in the population were either first-year birds from nests that were not found in 2001 or adults, fledged from nests that were not found in earlier years or individuals that had lost their wing-tags (after an average of 3-4 years). The numbers of untagged first-years and adults in the population was estimated using the 'ratio method', as described in 9.2, based on the number of tagged birds of each age group known to be using the roost (see table 8).

The final estimate of 67 birds given in table 8 is likely to be a slight under-estimate of the Midlands population due to the under-recording of wing-tagged individuals at the roost. In all, 44 different individuals were identified from wing-tags and each was recorded, on average, 4.6 times. Although the majority of birds were seen several times, seven individuals were recorded on only one occasion and it is therefore likely that a few others went entirely unrecorded. This is thought to involve only a small number of birds and the population estimate in table 8 is thought to be very close to the actual Midlands population.

Table 8: Number of red kites in the Midlands population, winter 2001/02

Year/age group	Wing-tag colour Left wing/Right wing	Number of birds
2001	White/Blue	18
2001 – untagged	n/a	7[1]
2000	White/Pink	10
1999	White/Black	6
1998	White/Green	6
1997	Red/Red	4
Adults – untagged	n/a	15[2]
Chilterns 1997	Black/Black	1
Total population estimate	**n/a**	**67**

[1,2] Estimated by 'ratio-method': Of 138 first-year birds recorded, 37 were not tagged and 101 were tagged; 37/101 * 18 = 7 birds. Of 297 adults, 107 were not tagged and 190 were tagged; 107/190 * 26 = 15 birds.

9.4 'Flush' counts at the communal roost

An alternative method used to estimate the Midlands population involved actually counting birds during visits to communal winter roost site. Birds usually arrived at the roost in small numbers and from different directions, and used pre-roosting trees scattered over a wide area. Some individuals flew back and forth between the roost wood and adjacent areas during the pre-roost period and so it was not practicable to make an accurate count as birds arrived at the roost. In windy weather large gatherings of up to 40-50 birds sometimes circled together over the roost wood or adjacent fields before settling in the trees. However, such gatherings involved only a proportion of the birds present and so could not be used to accurately assess total numbers. Viñuela (1997) used this method to count birds at roosts in Spain but conceded that the counts may well have been significant underestimates.

A more accurate method for counting birds at the roost was to wait until dusk when the majority of birds were settled within woodland at their final roosting location and then flush them from the trees by walking noisily through the woodland. Several people were used to flush birds and two observers watched from a high point overlooking the roost wood. On the single occasion when this method was employed in the Midlands the flushed birds gathered together above the roost wood and then flew quickly, in a reasonably compact group, to an alternative woodland block in the same area. They were counted individually as they flew past the two observers while on route to the alternative roosting site with one observer noting 60 birds, the other 61 birds. The count was made on 4th January, when there was virtually no wind. It is likely that in windy conditions the flushed birds would fly more erratically making it more difficult to achieve an accurate count. This count easily exceeded the maximum number of birds previously seen together at the roost. A higher figure may have been obtained by repeating the count on several days but only a single count was undertaken to avoid causing excessive disturbance.

The population estimate obtained using this technique was lower than the estimate given in table 8 (61 against 67), and a combination of the factors listed below may help to explain this:

(i) It was impossible to be sure that all the roosting birds present were flushed. Some may have remained perched even when approached closely while others may have been roosting away from the main concentration of birds.

(ii) Some adults do not attend the roost each night, probably roosting instead at their breeding site.

(iii) A small number of very late arrivals may not have settled at their final roosting location at the time the count was carried out.

Despite its limitations, this method can clearly provide a useful minimum population estimate provided that the major roost site/s for an area are known. The method may be particularly useful in future years when birds are no longer routinely fitted with wing-tags and estimates based on ratios of tagged and untagged birds are not possible.

10. Nest sites and breeding ecology

In the early years of the project it is thought that all, or almost all, of the breeding pairs were found and regular visits were made to nests to monitor progress and record details of the nest site and immediate surroundings.

10.1 Locating red kite breeding pairs

Pairs were most easily detected at potential breeding sites early in the season, the key period extending from late February through March. During this period, pairs spent considerable time on their territory, either perching in trees or circling over the area. Display flights lack the flamboyance seen in some other birds of prey and were mainly restricted to slow circling above the nest wood. Calling became more frequent than outside the breeding season and aggression towards corvids and other birds of prey was often witnessed. Some pairs were seen at more than one site early in the season before settling on one to make a breeding attempt. Other pairs spent much time at a single site before suddenly switching to a nearby alternative, on one occasion even after a nest had been built.

After the eggs were laid, usually in the first two weeks of April, there was far less activity and pairs became much more difficult to locate. Females spent the majority of their time sitting on the nest and males were either away from the nest area searching for food or perched unobtrusively close to the nest. At this stage, searching for the nest itself was a useful means of locating pairs, although this became much more difficult once the majority of woodland trees were in leaf.

Guidance supplied to individuals carrying out fieldwork for the 2000 UK breeding survey (Wotton *et al*, in prep.) included the following signs that indicate a potential breeding pair, and reflect the importance of the early part of the breeding season:

Early season

(i) Aggression towards another red kite, other bird of prey or corvid
(ii) A calling adult red kite
(iii) Circling by one or two adult red kites for two minutes or more over the same area of woodland
(iv) Play-fighting or chases involving two birds
(v) Diving down through the canopy into a woodland, or flying below the canopy within woodland
(vi) Carrying nest material (stick, dry grass, wool, paper or plastic) to woodland

Post egg-laying

(i), (ii) and (iii) as above
(vii) Exaggerated deep-flapping flight (often undertaken when an intruder is close to the nest)
(viii) Carrying food into woodland
(ix) Bird sitting on a nest or flying from a nest that is approached
(x) Young birds on, or, if recently fledged, close to, a nest

Only (ix) and (x) should be regarded as confirmation that a breeding attempt (reaching at least the egg-laying stage) has been made.

10.2 Nest site selection

The red kite does not have exacting requirements for its breeding site either in terms of the individual tree used for building the nest or the type of woodland chosen. In the Midlands, nests were found both in very small woods, including narrow shelter-belts, and within some of the largest woodlands in the area. Some nests were located high up in a large, mature tree, while others were only 8m or so above the ground in one of the smallest trees within a woodland block.

One common factor to almost all nest sites was the presence of an adequate aerial route into the nest for the long-winged adults. This was achieved either by building the nest close to the edge of a wood or adjacent to a woodland ride or clearing. Unthinned, commercial plantations with densely packed trees were avoided. Nests were often built in a substantial fork, either against the main trunk or at the junction of several major branches within the canopy. Less often, nests were found resting on the top of horizontal side branches, several metres away from the main trunk. These nests were more vulnerable to becoming dislodged from the tree and several nests with eggs or chicks failed because of partial collapse.

Table 9: Red kite nest sites in the Midlands, 1996-2000

Tree species	**Number of nests**	**Nest height** Average (range) in metres
Broadleaf		
English/Sessile oak	18	15 (11-20)
Turkey oak	1	20
Field maple	1	10
Sycamore	1	15
Ash	2	18
Conifer		
Norway spruce	3	10 (8-12)
Scots pine	3	14 (9-17)
Larch	2	15.5 (11-20)
Total	**31**	**15 (8-20)**

10.3 Age of first breeding

Most red kites in the Midlands, as in the other reintroduction areas in Britain, bred for the first time when they were two years old. The only reason that birds of two years or older did not breed was due to an imbalance in the sexes; the excess of males in the population meant that some were unable to find adult females with which to pair. These birds either paired with first-year females and made a breeding attempt or remained unpaired and did not breed until the following year.

Pairs involving two first-year birds sometimes held territory early in the breeding season and several such pairs constructed a rudimentary nest. They usually got no further than this before breaking up rather than remaining on territory and attempting to breed. This behaviour has been recorded in first-year birds in other red kite populations and is a means by which young birds gain experience for the following year when they come to make their first serious breeding attempt. In the Chilterns and Yorkshire, pairs involving two first-year

birds have bred successfully on rare occasions, the first time that this has ever been recorded in red kites (Evans, Cordero & Parkin 1998; Doug Simpson pers comm.).

In the period 1996-2000, a total of five pairs in the Midlands involving at least one first-year bird reached the egg laying stage. Four pairs involved a two- or three-year-old male paired to a first-year female, reflecting the imbalance in the sexes in the Midlands population. Two of these pairs failed at the egg stage, one pair reared a single chick and one pair reared two young. The single pair involving both male and female first-years failed at the egg stage. Although this is a very small sample size the low average productivity in comparison with older pairs is consistent with findings in the Chilterns and northern Scotland (Evans *et al* 1999)

10.4 Roles of male and female in breeding

As with many raptors, it is the female red kite that undertakes the majority of the incubation of eggs and brooding of chicks, while the male provides most of the food from the pre-laying period until at least the time when the chicks are old enough to be left unprotected. At one Midlands nest involving a first-year pair, it was possible to check the sex of the incubating bird remotely by radio-tracking. On only three out of 21 (14%) checks was the male found to be on the nest. At several other nest sites it was possible to identify the incubating bird from its wing-tags. The male was recorded sitting on the nest on only six out of 38 (16%) visits where identification was possible.

Medina (2000) carried out a detailed study of a single nest site in the Midlands and showed by direct observation that it was the male bird that brought in almost all the food that was required during the brood rearing period. The female hardly ever left the immediate area of the nest and so was on hand to protect the single chick from potential predators and cover it in spells of wet weather. Pictures from a CCTV camera set up at a nest in 2001 also showed that it was the male that brought in the majority of the food to the nest and was usually only present at the nest for very short periods when dropping off food. The female spent much longer at the nest, brooding the chicks at times until they were about four weeks old and tearing flesh from carcasses in order to feed them.

Young remain dependent on the adults for around 3-4 weeks after they have made their first flight. During this time they tend to remain close to the nest and take food brought by the adults to the nest platform or a nearby feeding perch. Both adults are often involved in providing food at this stage but, at times, this task is carried out solely by the male and the female may spend long periods away from the nest area with little further involvement in rearing the young. This pattern of behaviour was observed at three nest sites in the Midlands in 1999 and 2000, in two cases involving an adult male paired to a first-year female.

10.5 Breeding site and mate fidelity

The red kite is well known for remaining faithful to the same nesting territory, if not always the same nest, for year after year (Walters Davies & Davis 1973). In a small, re-establishing population where there is very little competition for available nest sites there is perhaps more scope for moving to alternative sites between years and this was often the case in the Midlands. Between 1996 and 2000 a total of 32 breeding attempts were recorded. In all, there were only seven occasions when the same pair (or what was believed to be the same pair) used the same territory from one year to the next. There were also seven occasions

when a pair was known to have changed territories between years, involving a movement of at least 1km between nest sites. The average movement for these pairs was 3.6km with a maximum of 8km. Up to 2000 there was only one example of a pair reusing the same nest from one year to the next as most pairs that remained on the same territory built a new nest. There were two examples of a pair using a nest used by a different pair in the previous year. As population density increases and there is more competition for nest sites it is likely that faithfulness to an individual territory will increase.

As expected from studies elsewhere, most breeding pairs where individuals could be identified from their wing-tags, remained the same from one year to the next. There were no known instances of 'divorce' although as tags lasted only for an average of 3-4 years it is possible that a small number of cases went undetected.

10.6 Human disturbance

Regular visits were made to active nest sites in order to monitor each breeding attempt. Disturbance was kept to a minimum when pairs were incubating eggs or brooding small young as many species are more likely to desert the nest at this stage, and eggs and small chicks are potentially vulnerable to predators if left unattended. Once the chicks were about two weeks old, nests were often visited every few days, including one prolonged visit (usually about 60 minutes) in order to climb to the nest and fit wing-tags to the chicks. The reaction of the adults to human disturbance varied greatly. Some pairs circled high above the area but remained silent, whereas other pairs circled only just above the treetops, calling repeatedly. It was noticeable that pairs involving first-year birds were more sensitive to disturbance than adult pairs. The incubating bird often quickly left the nest when approached, whereas adults were more likely to sit tight, even when the nest was approached closely. In view of this, visits to the nest sites of inexperienced pairs were kept to an absolute minimum at the incubation stage.

Forestry operations including thinning, clear-felling and coppicing are a frequently reported source of disturbance for woodland-nesting birds of prey in Britain. In recent years, there have been several incidents where such activities are thought to have resulted in the failure of red kite breeding attempts in England (Nigel Snell pers comm.). Petty (1989) recommended that no major forestry operations should be carried out within 400m of an active goshawk nest and the same recommendation is made here for red kite nests in the breeding period (March to July inclusive).

Several red kite nests in the Midlands were close to a road, footpath or farm building and the adults quickly learnt to ignore routine human activity within sight of the nest. The red kite clearly does not require nest sites that are completely isolated from human activity and, for this reason, the high human population density in much of lowland England should not unduly restrict the red kite's potential for range expansion.

10.7 Breeding productivity

During the period 1996-2001 a total of 43 breeding attempts (where eggs were laid) resulted in the production of 74 young, an average of 1.7 young per breeding attempt. Of the 43 breeding attempts, 30 resulted in the production of at least one young, an average of 2.5 young per successful pair. In most cases fledging was confirmed by observations of young birds flying around the nest site. In some cases, however, chicks fitted with wing-tags when

4-6 weeks old were assumed to have fledged successfully and are included in the totals in table 10. Productivity in the Midlands was slightly lower than in the Chilterns and northern Scotland during the same period, but similar to typical figures for breeding populations in continental Europe and much higher than in Wales (Carter 2001). This, together with the relatively high survival rates for released and wild-fledged birds, confirms that the area provides suitable conditions for the red kite, including a more than adequate food supply.

Table 10: Red kite breeding attempts in the Midlands, 1996-2001

Breeding attempts	**Failed at egg stage**	**Failed at chick stage**	**Successful – number of young fledged**			
			1	**2**	**3**	**4**
43	6[1]	8	4	10	14	2

[1] Includes one failure where the pair laid a second clutch and bred successfully

The reasons for breeding failure were usually unknown. For the five sites where the cause of nest failure was identified, two involved secondary poisoning of well-grown young and three involved the partial collapse of the nest structure.

11. Home range and population density

Monitoring based on the re-sighting of wing-tagged birds and radio-tracking provided an ideal opportunity to determine home ranges, both in winter, when the population was centred on a single communal roost site, and during the breeding season when pairs were settled at breeding sites. This work showed that the area was able to support relatively high densities of birds and, based on experience in the Chilterns, it is likely that densities will increase further in the coming years, before there is a significant expansion in the population range.

11.1 Home range in winter

The focal point for the Midlands red kite population in winter is the main communal roost site, which has remained constant since soon after the first birds were released. Intensive radio-tracking of released birds in their first year allowed a detailed assessment of winter home range. Figure 2 shows radio-tracking locations for the ten 1996-released birds that remained in the Midlands during their first winter. The majority of records are concentrated in an area of approximately 40km^2. Only a small proportion of records were more than 4km away from the communal roost site attended each night by the ten radio-tagged birds, together with several birds released in 1995. A small number of records well to the south of the main range involved birds returning briefly to the area of their release aviary.

Figure 2: Winter range of red kites in the Midlands based on radio-tracking locations (the background grid is made up of 1km squares)

Although the Midlands population has increased rapidly since the winter of 1996/97, to around 70 birds in 2001/02, ranging behaviour remains much as in figure 2. The majority of birds in the population continue to use the same communal roost and are only rarely recorded more than 4-5km away from the roost during the day. The increase in population has resulted in an increased density of birds (utilising roughly the same 40km^2 area as in 1996/97), rather than a significant increase in range. If the population continues to increase then there will clearly come a point in the future when increasing competition will force some birds to range more widely in the search for food.

The red kite does not defend an exclusive home range at any time of year and, particularly in winter, the foraging ranges of individual birds show a high degree of overlap. Home ranges determined for six radio-tagged first-year birds in winter 1996/97 varied from 19 to 32km^2 with a mean of 23km^2. As is clear from the three examples plotted in figure 3 there are areas within each home range that are used more frequently than would be expected by chance. This is no doubt partly the result of local differences in food availability but also reflects the preferences of individual birds. The bird in (a) favoured an area to the west and north-west of the roost, whereas the bird in (c) spent little time in this area and was recorded more often to the south of the roost.

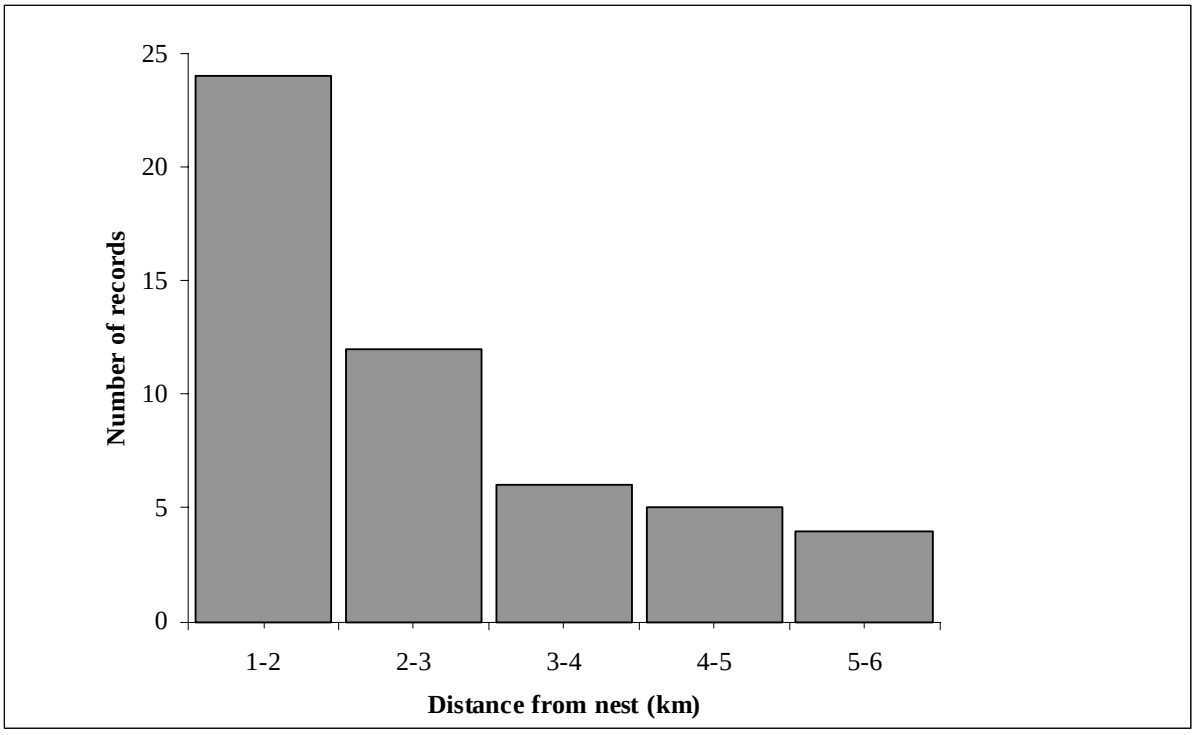
Figure 3: Winter home ranges for three first-year red kites in the Midlands, 1996/97 (the background grid is made up of 1km squares)

11.2 Home range in the breeding season

There is less complete information on the ranging behaviour of breeding adults because the majority of radio-tracking work has involved young birds before their first breeding attempt. Some information has been collected in an unsystematic manner by recording wing-tagged adult birds whose breeding site was known.

Figure 4 is based on 51 records of individually marked birds (from many different pairs) seen at least 1km away from their nest site during the incubation and chick-rearing period. Almost all such records involved the male of the pair and females were only very occasionally identified more than 1km from their nest site during this period. The majority of records were within 3km of the nest site showing that breeding adults in the Midlands did not have to travel long distances from their nest in order to find sufficient food to rear their young. Eight out of the nine records where a bird was seen more than 4km away from the nest involved a single male in a year when the pair had moved 5km from their previous year's nest site. Despite the change of breeding site, the male was regularly seen foraging over fields close to the previous year's nest, requiring far longer flights from the nest than was usual. It was presumably advantageous for this bird to make use of foraging areas with which it was familiar from the previous year, despite the longer flights that this entailed. A more detailed assessment of breeding season home ranges will be possible through radio-tracking adults carrying long-life radio transmitters.

Figure 4: Foraging distances from nest sites in the Midlands, 1996-2000



Although the red kite is less highly social in the breeding season than in winter, foraging ranges were not defended from other red kites and the home ranges of neighbouring pairs overlapped considerably. Nest sites were usually at least 1km apart although there were two active nests within 400m in 2000. Of the 16 breeding pairs located in 2000, 11 were within 5km of the roost area (at a rough density of 1 pair/7km^2), and the other five pairs were all within 10km of the roost. In the Chilterns, where the breeding population reached a

minimum of 120 pairs in 2001, densities of c.50 pairs/100km^2 have been reached, and nests are regularly found within a few hundred metres of each other (Nigel Snell pers comm.). It is likely that if the Midlands population increases as expected during the next few years, this will result in a substantial increase in density before there is a significant increase in breeding range.

12. Diet and foraging habitats

The results of extensive studies of diet in the Midlands have shown that the red kite is a generalist and opportunist scavenger, taking a wide range of different food types, depending on local availability. Field observation in winter confirmed that the overwhelming majority of food was taken as carrion. In the breeding season much food was taken as carrion but some prey, notably woodpigeon nestlings, were probably killed. The red kite is dependent on human activities for much of its food and, as a result of its scavenging nature, is vulnerable to illegal poisoning and accidental secondary poisoning. Much of the information in the following sections is taken from Carter and Clarke (in prep.).

12.1 Methods of studying diet

The diet of red kites in the Midlands was studied by direct observations of foraging birds (aided by radio-tracking), the analysis of remains in regurgitated pellets found at nest sites and communal winter roosts, and from food remains found at nests sites. Pellets were examined under a high-powered microscope and food types identified from the remains of feather, fur or other indigestible remains.

There are potential biases arising from each of the three different methods as can be clearly seen by comparing the figures in table 11. Pellet analysis may favour the recording of mammals over birds if fur survives better than feathers in the red kite's acidic stomach. This was suspected from the high proportion of bird remains found at some nest sites but the far lower proportions present in pellets from the same nests. Food remains at nest sites will bias the results in favour of the larger, more obvious, species where remains are more likely to be found. Small prey brought to the nest will result in only small amounts of waste or may even be swallowed whole leaving no remains. Birds may be favoured due to the greater amount of waste in the form of tail, wings and body feathers, likely to be more scattered and obvious than fur. The direct observation of feeding birds is also likely to favour the recording of larger species as these take longer to consume and are more easily seen at a distance. Small prey items may be picked up and carried to a secluded feeding perch or quickly swallowed whole making observation less likely. The best overall impression of the importance of different food types is derived from considering the results from each of the three sources of information and taking into account the likely biases of each.

Table 11: Important vertebrate food types in the diet

Food type	**Proportion (%) of food in diet**			
	Winter pellets (n = 346)	**Winter observations** (n = 117)	**Nest site pellets** (n = 183)	**Nest site food remains** (n = 191)
Lagomorph	32	61	39	27
Common rat	16	8	9	8
Small mammals	20	0	16	4
Gamebirds	10	12	6	25
Pigeon/dove	10	1	17	19
Corvid sp.	2	0	3	10
Other	10	18	10	7

12.2 Diet in the breeding season

Due to the large amount of time devoted to locating and monitoring nesting pairs, little time was spent in the direct observation of foraging birds during the breeding season. Diet was assessed solely from the analysis of pellets (table 12 and 13) and food remains found at, or close to, nest sites (table 11).

Lagomorphs were by far the most important food in the breeding season, representing 18-64% of vertebrate feeds in pellets from individual nests. It was impossible to specifically identify the remains of rabbit and brown hare from pellets but food remains found at nests indicated that rabbits were taken far more frequently, reflecting their abundance in the area. Some of the remains were from full-grown animals that were undoubtedly taken as carrion rather than killed. Common rats were found in pellets from all nests, representing 3-27% of vertebrate feeds at individual nest sites. Field voles were recorded fairly frequently although they were absent or at very low levels at a number of nest sites. The remains from sheep and deer were found on four and two occasions only, showing that that large mammals were of very little importance in the diet.

Gamebirds and pigeons/doves were the most important bird species in the breeding season, and their remains were often prominent at nest sites. Pheasants greatly outnumbered red-legged partridges and most were full-grown birds that were certainly too large to have been killed by red kites. Most of the pigeon remains were woodpigeon, including a high proportion of young birds. Some were nestlings too young to have made their first flight and so were presumably taken by the adult red kites direct from their nests. Young woodpigeon were prominent in the remains found at one nest site in two consecutive years suggesting that the adults had learnt to exploit pigeon nests as a food resource. The remains of young corvids, particularly crows/rooks were found at nests fairly frequently but were only occasionally recorded from pellets. A large number of other bird and mammal species were recorded occasionally at nests, demonstrating the generalist nature of the red kite (table 13).

Earthworm remains were found in 9% of a sample of 160 breeding season pellets that were checked specifically for earthworm chaetae. They were probably eaten only by the breeding adults as prey of such a small size would not be worthwhile carrying back to a nest site to feed chicks.

Table 12: Proportions (%) of the main vertebrate foods found in pellets from nest sites

Nest site code Year	**A** **1997**	**B** **1997**	**C** **1997**	**B** **1998**	**D** **1999**	**E** **1999**	**F** **1999**	**A** **1999**	**Mean**
(*n* feeds=) **Food type**	(31)	(39)	(42)	(39)	(49)	(74)	(46)	(18)	(42)
Lagomorph	64	43	38	25	18	32	41	50	39
Common rat	10	5	7	10	27	3	4	6	9
Small mammals	6	3	12	23	6	22	28	28	16
Gamebirds	10	5	10	3	10	11	0	0	6
Pigeon/dove	0	39	7	36	4	23	18	11	17
Other	10	5	26	3	35	9	9	5	13

Table 13: Occurrence of vertebrate foods in pellets from nest sites

Nest site code and year (*n* pellets =)	**A: 1997** (22)	**B: 1997** (21)	**C: 1997** (22)	**B: 1998** (21)	**D: 1999** (24)	**E: 1999** (35)	**F: 1999** (26)	**A: 1999** (12)
Lagomorph	20	17	16	10	9	24	19	9
Common rat	3	2	3	4	13	2	2	1
Field vole		1	3	6	2	12	9	5
Bank vole							1	
Mole				1	1	3	2	
Unidentified small mammals	2		2	2		1	1	
Hedgehog			1					
Sheep			3		1			
Deer sp.			1					1
Red-legged partridge	1		1		1			
Pheasant	2	1		1	3	8		
Domestic fowl			2		1			
Galliforme sp.		1	1					
Lapwing	1							
Pigeon/dove		15	3	14	2	17	8	2
Pied wagtail			1			1		
Blackbird					1	1		
Song thrush		2	1					
Jay					1			
Corvid sp.			2		6		1	
Starling	1		1					
Chaffinch					1			
Greenfinch					2			
Reed bunting							1	
Unidentified bird sp.	1		1		1	4	1	2
Snake sp.							4	

12.3 Diet outside the breeding season

There was no evidence from extensive periods of field observation that red kites in winter took significant amounts of live prey, with the exception of invertebrates. On only one occasion was a bird witnessed actively hunting, in this case dropping down into long grass, probably in an attempt to catch a small mammal.

Lagomorph was by far the most important food for red kites in winter, as it was in the breeding season. Direct observations of feeding birds confirmed that the majority of lagomorph carcasses were rabbit rather than brown hare. Common rats were the next most important food, comprising 16% of food items identified in pellets and 8% of observations of feeding birds. Small mammals were taken frequently, particularly wood mice and, in 1996/97, field voles. No field voles were recorded in pellets collected in 1997/98, probably reflecting a natural low in their population cycle.

The most important birds in the diet were gamebirds and pigeons/doves. Gamebirds were dominated by pheasants, which were released in large numbers in the area each winter and suffered high levels of mortality on roads, and through shooting and predation. It was impossible to identify pigeon/dove remains to species level but the most abundant species in the area is the woodpigeon.

As in the breeding season, a significant part of the diet was made up of small numbers of a wide variety of different species. It appears from the long list of species recorded in pellets (table 14) that the generalist red kite will probably feed on almost any small or medium sized animal carcasses that it comes across in the open.

The remains from larger mammals such as sheep were rarely recorded, in contrast to their importance in the diet in central Wales (Davis & Davis 1981). Such carcasses do not often become available to red kites in the lowlands as mortality rates are low and those animals that do succumb are quickly found and disposed of by local farmers. Large carcasses are, in any case, difficult for the weak-billed red kite to penetrate and the relative abundance of more accessible and manageable food sources in the Midlands means that they were unlikely to be favoured even when available.

Earthworm remains were found in 8% of a sample of 174 winter pellets checked for earthworm chaetae and red kites were frequently seen feeding on them in both pasture and bare arable fields. On several occasions in early autumn red kites were seen taking flying insects on the wing. These included craneflies (*Tipula* sp.) which were taken in circling flight at considerable height and delicately transferred from foot to bill in a manner more befitting a hobby.

Table 14: Occurrence of vertebrate foods in winter roost pellets 1996/97 and 1997/98

Food type	1996/97						1997/98					
	Oct	Nov	Dec	Jan	Feb	Mar	Oct	Nov	Dec	Jan	Feb	Mar
Lagomorph	3	16	12	26	20	33	9	8	6	12	8	9
Common rat	2	2	9	11	6	34	2	5	1	9	1	12
Wood mouse		5	4	10	12	14	2	1	5	4	1	3
House mouse												1
Field vole	1	15	4	7	3	3						
Bank vole				3	1	1						1
Mole		1		1		2						
Shrew sp.				1	2							
Small mammal sp.	1	2		1		1	1		1			1
Weasel					1							
Grey squirrel											1	
Sheep						1						
Deer sp.						1	1					
Mallard					1	1		2				
Duck sp.			1		2	1						
Goose sp.						1						
Common kestrel					1							
Red-legged partridge	1			2			1	1				
Pheasant		3	3	3	2	6	1	3	1	3	2	2
Domestic fowl		2		2								
Turkey										2		
Galliforme sp.					1		1	1	2	5		
Moorhen			1		2	1						
Rail sp.				1		1						
Woodcock						2						
Wader sp.				2								
Gull sp.				1								
Pigeon/dove		1	1	4	6	10	3	1	5	7	4	7
Green woodpecker			1									
Meadow pipit			1									
Blackbird								1				
Fieldfare				1								
Redwing											1	
Mistle thrush										2		
Magpie			1									
Corvid sp.		1							1		3	2
Starling				2								
Unidentified bird sp.	2	1							1	2	1	3

12.4 Foraging habitats

The red kite is a highly adaptable and generalist species and clearly has no problems in finding sufficient food in the intensively managed, arable-dominated landscape surrounding the Midlands release area. The figures in table 15 show that red kites in winter did not actively avoid arable fields. The number of observations of birds associated with arable farmland was roughly as expected from the proportion of this land-use category present in the area. Observations involving only birds that were seen feeding confirmed that the same was true for birds that were actively foraging for food. There was, however, the indication of a slight preference for grassland as 26%

of observations were associated with this category, compared with the 20% expected according to its availability in the area.

There was a tendency for red kites to avoid woodland when foraging, as expected from a bird that relies on its keen eyesight to locate food in mainly open countryside. The birds that were recorded flying over woodland in winter were no doubt either travelling from one area to another or simply circling over the area with no intention of searching for food. Woodland is, however, an important component of a kite-friendly landscape as it provides breeding and roosting sites, and is a valuable habitat for many of the species frequently recorded in the diet.

Table 15: Association with different land-use categories in winter (September-February), 1995-99 (from Carter & Grice 2000)

Land-use category	**Red kite observations (%)** (n=411)	**Land-use category in the study area (%)**[1]
Arable farmland	62	60
Grassland	26	20
Woodland	11	15
Other (including built land and water)	1	5

[1] Approximate values based on 1996 MAFF farm census data for agricultural land, and Ordnance Survey data for woodland

12.5 Dependence on human activities

Observations suggested that red kites in the Midlands were either directly or indirectly reliant on human activities for much of their food. Road kills appeared to be an important source of food as there were frequent reports of red kites feeding at roadside carcasses, particularly early in the morning. Further evidence came from food remains found at nest sites, including intact bird carcasses with a broken wing, probably sustained when hit by a vehicle, and mammal carcasses squashed flat by passing traffic before being retrieved and carried to the nest. Marchant and Gregory (1999) suggested that rising traffic densities and the resultant increase in road kills could help to explain increases in the populations of rooks and other scavenging corvids. The red kite is also likely to benefit from this trend.

Pest control operations provided another important source of food when they resulted in animal carcasses being left out in the open and so available to scavengers. Rabbits were sometimes left where they fell following shooting campaigns by farmers, as they were of too little value to be worth collecting. In winter, large numbers of woodpigeon were shot in order to protect winter oil seed rape crops and those not collected for human consumption also became available to scavengers. The main method of controlling common rats in the area was by poisoning and although the majority of animals killed in this way probably died underground, some no doubt died in the open. Other pest species, including corvids, grey squirrel, stoat and weasel,

were controlled mainly by trapping and only became available to the red kite if deliberately left out in the open by whoever was checking the traps.

The release of large numbers of gamebirds for shooting on several local estates provided another valuable source of food. High densities of gamebirds can result in considerable mortality and the red kite was able to exploit this even before the birds were released into the wild. One local gamekeeper reported that hen pheasants killed by a wasting disease were regularly taken from within a large, open-topped, laying pen. Full-grown pheasants would usually be too heavy to lift back to the nest site whole but, in this case, they were well below normal weight due to the wasting effects of the disease. Not all birds killed during shoots are retrieved by the gun dogs and these provide a further potential source of food. Some keepers in the Midlands have even claimed that red kites were sometimes attracted into an area by the sound of gunfire as if they had learnt that carcasses would soon become available.

Other potential sources of food resulting from human activities include invertebrates and small mammals disturbed or killed during agricultural operations (red kites were sometimes reported by farmers following farm machinery) and food deliberately provided in large gardens by householders. This has become common practice in the Chilterns and is now also increasing in the Midlands.

12.6 Communal foraging

It is well known that the red kite is a highly social species. Large communal roosts form in winter (see section 8) and it is thought that birds improve their chances of locating food by foraging in loose groups, so called ‘network foraging’ (Mock, Lamey & Thomson). When one bird spots food, the others quickly converge to share in the discovery. Each individual therefore improves its chances of being able to find food and, as carcasses are often large enough to feed several birds, there is no disadvantage for the finder in having to share. Released birds in the Midlands were regularly seen in groups of up to 5-6 at food sources but also frequently foraged alone.

In order to quantify the degree to which the Midlands birds associated with each other when away from the communal winter roost, data from ten days of intensive radio-tracking in 1996/97 were used to calculate a coefficient of sociality using methods described by Kenward (1987). This procedure compares *actual* distances between randomly chosen ‘pairs’ of birds (from radio-tracking) with *expected* distances based on a random distribution within the birds’ overall home range. A coefficient of zero indicates that the two birds are moving independently of each other, it tends towards -1 if birds are actively avoiding each other, and towards +1 if they are always associated.

The coefficients calculated for five randomly chosen ‘pairs’ of first-year birds in the Midlands were 0.02, 0.06, 0.07, 0.19 and 0.03. Positive values, close to zero, suggest that the individuals in each ‘pair’ spent most time foraging independently of each other but were, at times, associated, presumably as part of the small groups of birds often observed in the area.

13. Mortality and threats

The following sections provide information on the main threats currently faced by the red kite in England, based on information on dead and injured birds not only in the Midlands but also from projects in the Chilterns and Yorkshire, up to the end of 2001. Much of the information has been derived from post-mortems carried out by Zoological Society of London's Institute of Zoology, tissue analysis by the Government's Central Science Laboratory as part of its Wildlife Incident Investigation Scheme, and tissue analysis carried out by the Centre for Ecology and Hydrology at Monk's Wood.

Despite the intensive monitoring associated with the reintroduction programme, only a small proportion of the birds that died were recovered so that investigations into the cause of death could be carried out. Based on estimates of survival rates for released birds in England and the known number of carcasses that were recovered, Holmes *et al* (2000) estimated that only about one in five birds were found while still fresh enough to allow a full post-mortem. The others were either never found or were found long after death when there was little hope of establishing the reason for mortality.

The extent to which the figures for each mortality factor have under-represented the total number of deaths will vary between factors due to the different probability of locating fresh carcasses. Birds killed illegally, for example, may have been greatly under-represented as the carcasses were much more likely to have been concealed by the perpetrator. Birds that died from natural causes were also likely to be under-recorded, as when birds start to feel unwell they tend to seek seclusion and cover where they are less vulnerable to predators. They are therefore less likely to be found than in the case of a bird killed quickly by collision or electrocution, for example, that dies out in the open.

The only deaths and injuries not included in the tables are small nestlings, killed by their siblings or poor weather, and a single case when a well-grown nestling in the Chilterns was found injured by plastic wrapped tightly around its leg.

13.1 Illegal poisoning

This has been the major threat faced by the red kite during the last 150 years or more and one of the main factors that led to the complete loss of the species from England by the late 19th century. The red kite is particularly vulnerable to poison baits because of its scavenging habits and its social behaviour; a single bait can often result in the death of more than one bird. In most incidents it is unlikely that baits were used with the specific intention of killing red kites. It is more probable that they were used as a means of controlling pest species such as carrion crows, magpies or foxes. They are, however, completely indiscriminate and clearly there is no means of preventing the deaths of non-target species when such baits are used. The use of poison baits is thought to have declined over recent decades as a result of changes in the law, the Government's ongoing Campaign Against Illegal Poisoning and the introduction of alternative legal control methods for pest species such as Larsen cage trap for corvids. However, monitoring carried out during the reintroduction programme has shown that poison baits are still widely used and this is the most serious threat currently faced by the red kite in England. Since the first birds were released in 1989, a total of 21 birds

have been found dead as a result of illegal poisoning in England and a further bird was found poisoned but recovered and was re-released.

Table 16: Poisons used in incidents involving red kites in England

Poison	Number of red kites killed	Notes
Mevinphos	9	Including 3 recently-fledged birds killed in a single incident in the Midlands, 2000
Alphachloralose	5	In addition 1 bird recovered and was re-released
Aldicarb	3	Including both birds of a breeding pair in Yorkshire, 2000
Endrin	1	
Metaldehyde	1	
Carbofuran	1	The most commonly abused poison in Scotland; it has recently been removed from the list of officially approved pesticides in the UK
Phorate	1	

With the exception of alphachloralose, the poisons in table 16 are all agricultural pesticides. The most commonly abused poison was mevinphos, which is no longer commercially available and has presumably been stockpiled by those wishing to use it illegally. Alphachloralose is a narcotic used as a bird-stupefying agent and is also used as a rodenticide. The high concentration formula used in illegal baits is only commercially available under licence to pest controllers.

It is hoped that publicity associated with illegal poisoning incidents will help to increase awareness of this issue and encourage the use of alternative, legal forms of pest control. The successful prosecution of an individual in the Chilterns for illegally poisoning red kites in 1997 received considerable publicity and the large fine imposed (£13,500 for various related offences) has no doubt had a deterrent effect on others considering the use of illegal poison baits.

13.2 Accidental secondary poisoning

(i) Rodenticides

This issue is covered in more detail in Carter and Burn (2000) and Shore *et al* (2000) from which much of the following information is taken. Second-generation anticoagulant rodenticides include bromadiolone and difenacoum, which may be used to control rodents in any situation, and flocoumafen and brodifacoum, licensed for use only against indoor populations of rodents. They have replaced first-generation anticoagulants such as warfarin and coumatetralyl in many areas but are up to about 600 times more toxic and also far more persistent in body tissues once ingested. They are effective in areas where rats have become resistant to first-generation products and are perceived to be more effective even in areas where resistance is not a problem so their use has become widespread.

Predators and scavengers are vulnerable to secondary poisoning when they feed on poisoned rodents and problems have already been highlighted for barn owls (Newton *et al* 1999; Newton, Wyllie & Freestone 1990) and polecats (Shore *et al* 1996).

Studies carried out in the Midlands have shown that red kites are particularly vulnerable to this form of poisoning for the following reasons:

(i) Rats form a significant part of the diet throughout the year.

(ii) As a result of the red kite's scavenging lifestyle, mainly dead rats will be taken, increasing the likelihood that poisoned individuals will be selected.

(iii) Red kites are relatively tolerant of people and often forage around villages and farm buildings where rodent control is frequent.

Liver samples from 20 birds found dead from a range of causes in England between 1994 and 1999 were tested for second-generation rodenticides through a contract with the Centre for Ecology and Hydrology, and 14 (70%) were found to contain residues, showing that contamination is widespread (Shore *et al* 2000). It is not known how many of these birds were killed by rodenticide poisoning, as our understanding of the significance of different residue levels in the liver is incomplete. However, post mortems carried out on fresh carcasses sometimes revealed internal bleeding and where rodenticide residues were subsequently found in the liver, this was attributed to the anticoagulant effect of the rodenticide. In the Midlands and the Chilterns combined, this work found that rodenticide poisoning was the likely cause of death for a minimum of eight birds in the period 1998 to 2001, four nestlings and four full-grown individuals.

(ii) Lead

Lead poisoning has long been recognised as a potential problem for raptor species that feed on prey killed or injured by shooting. Pain *et al* (1993) showed that marsh harriers in southern France were sometimes killed as a result of scavenging on wildfowl killed by lead shot or by taking live birds that contained lead shot from a non-lethal injury. Although lead ingested by a bird of prey is subsequently regurgitated, along with other indigestible material from prey, during the time it is in the acidic stomach it may dissolve, releasing lead into the bloodstream. In some cases it is thought that the lead from a single piece of shot may be sufficient to result in death but it is also possible for a bird to accumulate a lethal dose through repeatedly ingesting and regurgitating lead shot over a period of time (Pain, Sears & Newton 1995).

It is known that red kites in England do at times ingest lead shot when scavenging on animals that have been killed by shotgun. A study of regurgitated red kite pellets collected from the Midlands communal winter roost found lead shot in four out of 346 pellets analysed (Carter & Clarke in prep.). The four pellets contained the remains of red-legged partridge, pheasant, pigeon/dove and lagomorph (rabbit or hare) respectively, suggesting the likely source of the lead shot in each case. In the Midlands release area large numbers of gamebirds are shot each winter and, inevitably, not all the carcasses are recovered. Woodpigeons and rabbits are frequently shot as agricultural pests and carcasses are sometimes left where they fall rather than collected for human consumption. All these species are common in the diet and so there is clearly a risk that lead will be ingested regularly.

Samples of liver tissue from 20 red kites found dead in England in 1994-1999 were analysed for lead through a contract with the Centre for Ecology and Hydrology. Eleven of the birds were found to have detectable levels of lead but only one was considered to be above normal background levels, expected from the ubiquitous presence of lead in the environment (Shore *et al* 2000). This bird had 5.11ug/g wet weight of lead in the liver and it was concluded that it 'may have been suffering from symptoms of lead poisoning that could possibly have proved fatal'. The post mortem that was originally carried out on this bird when it was found dead in 1996 concluded that disease was the likely cause of death. Now that it is known that it contained high lead residues this must be considered as a possible factor in the death of the bird.

There is one other incident where lead poisoning is thought to have resulted in the death of a red kite in England. A bird taken from a nest in the Chilterns and translocated to Yorkshire in 2000 failed to develop properly when in captivity in the release pen. It was taken for veterinary treatment but its condition deteriorated. A blood sample revealed lead levels of 7.9mmol/litre and it was thought that lead poisoning was the most likely cause of death (Andrew Cunningham pers comm.).

(iii) Agricultural pesticides

A small number of poisoning incidents in England are thought to have involved the misuse of agricultural pesticides, resulting from a failure to follow the product label instructions on good practice, rather than a deliberate attempt to poison wildlife. Two incidents in the Midlands involved nestlings that were found to contain residues of bendiocarb, a pesticide that is incorporated into seeds before sowing. It was thought most likely that these birds were killed by feeding on prey that had ingested treated seed, either not properly buried when sown or carelessly spilt in the open. In one of the incidents the remains of a woodpigeon containing pink-dyed, treated maize seed was found in the nest next to the dead nestling, providing convincing evidence of the route of exposure.

An incident in southern England in 1995 involved the pesticide phorate, which had been used to treat a crop of field beans. The product label recommendation that the pesticide should be incorporated into the soil was not followed. As with the bendiocarb incidents, the red kite was probably killed by secondary poisoning through feeding on prey that had itself ingested a sufficient quantity of pesticide.

In order to try and reduce the number of incidents involving secondary poisoning by rodenticides and agricultural pesticides, English Nature liases regularly with the relevant regulatory authorities and has encouraged the dissemination of guidance on how to use these products safely. Deaths resulting from the use of second-generation rodenticides may be reduced by encouraging alternative control measures such as the use of less toxic or persistent poisons, or trapping, and trying to ensure that the legally binding product label instructions are adhered to. It is particularly important that regular searches are made for dead rats in areas where poison is being used so that the carcasses can be disposed of safely by burning or burying.

13.3 Shooting

As is the case with poisoning, the red kite is particularly vulnerable to this form of persecution as its nest and roost sites are fairly easy to find and it often flies slowly, low over the ground in search of food, presenting a comparatively easy target. Added to this, the red kite is not particularly wary of people and so offers more frequent opportunities for shooting than is the case with other, more elusive, birds of prey. It is very difficult to assess the true extent of illegal shooting of red kites in England as birds shot and killed, or injured badly enough to be captured, will inevitably be concealed by the perpetrator. Only when the act of shooting is witnessed or if a bird is injured and later found and reported do incidents come to light and this is reflected by the seven incidents in table 21.

It is clear that there are still a small minority of people that view large birds of prey as a threat and are prepared to take the law into their own hands. Hopefully, as the red kite becomes more widespread, such individuals will come to accept that the species is here to stay and that resorting to illegal persecution is both unnecessary and futile.

13.4 Electrocution and collision with powerlines

Mortality associated with powerlines has been reported for a wide range of species around the world. In general it is the heavier species with a high wing-loading, and therefore lower manoeuvrability, such as wildfowl, that are vulnerable to collision with wires, whereas species with a large wing-span that habitually perch on the wire-supporting poles are most at risk of electrocution. The red kite with its generally leisurely flight and good eyesight, but large wingspan and long tail, is undoubtedly more at risk from electrocution that collision. There are 14 incidents involving birds found dead close to powerlines, detailed in table 19. In three cases scorch marks were visible on the carcass and so electrocution was confirmed as the cause of death. It is likely that some of the other birds also suffered the same fate but this could not be confirmed from the post-mortem.

Studies in Spain have shown that although the red kite is a regular victim of electrocution (e.g. Janss 2000) it is not as vulnerable as some other raptors that habitually use electricity pylons as a resting or hunting perch. The red kite is not often seen perching on poles or wires in England and this no doubt prevents it from being killed more frequently. There are means by which the threat from powerlines can be reduced, such as insulating dangerous sections of wire or providing artificial perches well above the wires and these may need to be considered in England if deaths from this cause continue to be reported regularly.

13.5 Collision with road vehicles, trains and aircraft

There have been a total of 11 incidents involving red kites killed or injured by collisions with road vehicles (6), trains (3) and light aircraft (2) - see table 19. Birds found dead on roads and railway lines were presumably attracted to feed on the carcasses of other species already killed by collision. In most cases where red kites have been observed feeding on road kills they have been very wary, preferring to swoop down and grab a carcass and carry it away to a secure feeding perch. This may not be possible with large carcasses but the red kite’s wariness about landing in an

unfamiliar situation means that is usually alert to danger and seems unlikely to be caught by surprise by an approaching vehicle. It is probable that most of the incidents either resulted from the inexperience of a young bird or because the individual involved was not fully fit.

The three incidents that involved trains are of concern because they were all reported by the same railway worker from a short section of track near High Wycombe in the Chilterns, during an eight-month period in 2001. It is believed that they were attracted to the area to feed on the many pheasants that had been killed by trains when walking across the track. It is likely that many other cases have gone unreported due to the low probability of carcasses being found.

Deaths from collision are perhaps inevitable for a species that has adapted to live in close proximity to human activity and there is probably little that can be done to prevent them from occurring in the future.

13.6 Egg collecting

The activities of egg collectors has been one of the most important factors in preventing a more rapid recovery of the small Welsh red kite population and even in recent years, clutches have been taken regularly from Welsh nests (Cross & Davis 1998). There have been only two recorded incidents in England, both in the Chilterns in 2000. One nest where a bird was known to have been incubating was later found to be empty and the tree had fresh spike marks showing that it had been recently climbed. Another incident was confirmed from entries in the notebook of an egg collector (Graham Elliot pers comm.). Other incidents have no doubt gone undetected but overall, it is thought that the impact of this outdated activity is minimal.

13.7 Mortality tables

The following tables include brief details for birds found dead or injured in England since the start of the reintroduction programme in 1989, for which a likely cause of death/injury could be established. The exception is table 18, which lists all birds for which residues of second-generation rodenticides have been found, including those with low levels that were not thought to have contributed to the death of the bird. Many birds are found when too badly decomposed for a full post mortem to be carried out. These are only included in the tables if found in a situation which suggests a likely cause of death, for example on a railway track or under powerlines. Some birds are included in more than one table either because the cause of death was unclear or because rodenticide residues were found in an individual known to have been killed by another cause.

Table 17: Red kite incidents in England involving illegal poisoning, and secondary poisoning by agricultural pesticides and lead, 1989-2001

Age of bird (Calendar year) Origin	Date found/ Location	Poisons detected	Cause of death/comments
1st year Chilterns	Nov 1989 Herefordshire	Endrin	Illegally poisoned
2nd year Chilterns	Oct 1990 Chilterns	Metaldehyde	Illegally poisoned
1st year Northern Scotland	Dec 1991 Cornwall	Alphachloralose	Illegally poisoned
2nd year Chilterns	Apr 1993 Bedfordshire	Phorate	Illegally poisoned
3rd year Chilterns	Mar 1995 Chilterns	Phorate 42mg/kg gizzard	Used legally to treat field bean crop but label recommendations for shallow incorporation in soil not followed
1st year Midlands	Oct 1995 Grantham, Lincs	Alphachloralose 30mg/kg kidney	Illegally poisoned
6th year Chilterns	Nov 1995 Chilterns	Mevinphos 4.8mg/kg crop 1.2mg/kg gizzard	Illegally poisoned
2nd year Chilterns	Dec 1995 Aldermaston, Berks	Alphachloralose - in crop contents	Illegally poisoned; recovered and was released back into the wild
3rd year Chilterns	Jan 1996 Chilterns	5.11ug/g ww of lead in liver	CEH thought lead levels 'could possibly have proved fatal' but also had trichomonas infection (see table 20)
3rd year Chilterns	Jan 1996 Chilterns	Mevinphos 5.7mg/kg gizzard	Illegally poisoned - successful Police prosecution
6th year Chilterns	Apr 1996 Chilterns	Mevinphos	Illegally poisoned in same area as previous incident
2nd year Chilterns	Apr 1996 Chilterns	Mevinphos	Illegally poisoned in same area as previous incident
1st year Chilterns	Aug 1996 Chilterns	Alphachloralose 500mg/kg crop	Illegally poisoned
2nd year Midlands	Apr 1997 Midlands	Mevinphos 3mg/kg gizzard	Illegally poisoned
Nestling Midlands	Jun 1998 Midlands	Bendiocarb 1.9mg/kg gizzard	Also residue bromadiolone (see table 18) - cause of death not known but secondary poisoning likely
3rd year Midlands	Jan 1999 Chilterns	Aldicarb	Illegally poisoned; also residues of brodifacoum and difenacoum (see table 18)
Age and origin unknown	Apr 1999 Dover, Kent	Carbofuran 2.8mg/kg gizzard	Probably illegally poisoned
3rd year Chilterns	Feb 2000 Silchester, Berks	Mevinphos 4.3mg/kg gizzard	Illegally poisoned; also residues of brodifacoum and difenacoum (see table 18)
2nd year Yorkshire	Apr 2000 Yorkshire	Alphachloralose 40mg/kg liver 170mg/kg stomach	Illegally poisoned
Nestling Midlands	May 2000 Midlands	Bendiocarb 16mg/kg gizzard	Pigeon carcase containing treated maize seed also found on nest; secondary poisoning likely
2nd year Yorkshire	Jun 2000 Yorkshire	Aldicarb 7mg/kg gizzard	Illegally poisoned – 2nd bird dead 10m away - no residues detected but presumably also illegally poisoned
Nestling Chilterns	July 2000 Captivity in Yorkshire	Lead 7.9mmol/litre blood	Lead poisoning - probably secondary poisoning when still in nest – treatment in captivity unsuccessful, euthanased
1st year Midlands	Aug 2000 Midlands	Mevinphos	Illegal poisoning - 2 birds dead on bait, 3rd c.500m away; all 1st years
2nd year Yorkshire	April 2001 Yorkshire	Alphachloralose 25mg/kg kidney	Illegal poisoning - found by part-eaten rat

Table 18: Red kite incidents in England involving second-generation rodenticides, 1989-2001

Age of bird (Calendar year) Origin	Date found/ Location	Bromadiolone	Difenacoum	Brodifacoum	Probable cause of death - Comments
		mg/kg liver			
2nd year Chilterns	Jan 1994 Chilterns	0.04	0.03	0.01	Aspergillosis, fungal infection
3rd year Chilterns	Jan 1996 Chilterns	0.1		0.05	Trichomonas infection
1st year Chilterns	Nov 1996 Chilterns	0.16	0.02		Probably killed by collision with vehicle
2nd year Chilterns	Jan 1997 Chilterns		0.02	0.21	Found under powerlines but cause of death not known
2nd year Chilterns	Jan 1997 Chilterns	0.01	0.03	0.19	Avian tuberculosis
3rd year Midlands	Mar 1998 Mid-Wales		0.21		Also 0.01 mg/kg flocoumafen; found under powerlines, electrocution likely
3rd year Chilterns	May 1998 Chilterns			0.98	Probably rodenticide poisoning
Nestling Midlands	Jun 1998 Midlands	0.14			Also residue bendiocarb; secondary poisoning likely; 7 out of 10 well-grown chicks in Midlands died at point of fledging but only 1 post-mortem
1st year Chilterns	Nov 1998 Chilterns	0.06			Not known
3rd year Midlands	Jan 1999 Chilterns		0.18	0.02	Aldicarb poisoning
6th year Chilterns	Feb 1999 Chilterns	0.02	0.12		Aspergillosis and traumatic injury to wing
2nd year central Scotland	Mar 1999 Gloucester-shire	0.1			Collision with vehicle possibly influenced by rodenticide poisoning
6th year Chilterns	Mar 1999 Chilterns	0.05	0.16	0.3 (CSL) 0.46 (CEH)	Point of egg laying - killed by rodenticide
2nd year Midlands	Mar 1999 Chilterns	0.1	0.05		Death attributed to rodenticide
2nd year Chilterns	Apr 1999 Chilterns		0.2	0.04	Death attributed to rodenticide
2nd year Chilterns	May 1999 Chilterns		0.06		Shot and wounded - subsequently euthanased
Recently-fledged Midlands	Jul 1999 Midlands	0.19			Several healed bone-fractures, also bleeding from brain and other wounds probably result of predation
Adult Origin unknown	Sep 1999 Chilterns	0.03	0.04		Found under powerlines - cause of death not known
3rd year Chilterns	Feb 2000 Silchester, Berks		0.15	0.06	Illegally poisoned by mevinphos
Nestling Midlands	July 2000 Midlands	0.27			Rodenticide poisoning: 1 of 3 dead young below the same nest
Nestling Chilterns	July 2000 Chilterns	0.05			Found below nest; internal bleeding probably result of rodenticide poisoning

Table 19: Red kite incidents in England involving powerlines and collisions, 1989-2001

Age of bird (Calendar year) Origin	Date found/ Location	Finding details	Probable cause of death – Comments
2nd year Chilterns	Feb 1994 Chilterns	Found under powerlines	Not known
2nd year Chilterns	May 1995 Chilterns	Found by roadside	Presumed collision with traffic
1st year Chilterns	Autumn 1995 Woburn, Beds	Wounded in collision with car	Treated and released back into wild (subsequently found poisoned)
2nd year Chilterns	Sep 1995 Llangdog, Wales	Found under powerlines	Not known
1st year Chilterns	Jul 1996 Chilterns	At foot of electricity pylon	Electrocution suspected but not confirmed; c.100m from nest
1st year Chilterns	Sep 1996 Chilterns	At foot of electricity pylon	Electrocuted - scorch marks visible on feet
1st year Chilterns	Nov 1996 Chilterns	Edge of fairly busy road	Presumed collision with traffic; rodenticide residue (see table 18)
2nd year Origin unknown	Jan 1997 Chilterns	Found under powerlines	Not known; rodenticide residue (see table 18)
1st year Midlands	Jul 1997 North Wales	Below electricity pylon, beneath pole with 'transformer box'	Electrocuted - scorch marks visible on feet
4th year Chilterns	Jan 1998 Chilterns	Close to powerlines	Electrocuted - scorch marks visible
3rd year Midlands	Mar 1998 Mid-Wales	Found under powerlines	Not known; rodenticide residues (see table 18)
6th year Chilterns	Feb 1999 Chilterns	Found injured on road	Aspergillosis found at post-mortem - may have pre-dated wing injury and so contributed to accident (see table 20)
2nd year Central Scotland	Mar 1999 Aldsworth, Gloucs	Found on road	Collision with vehicle; rodenticide residue (see table 18)
3rd year Midlands	Mar 1999 Grantham, Lincs	Found under or 'near' powerlines	Not known; not 100% certain that initial location was under powerlines
3rd year Chilterns	Apr 1999 Chilterns	Found under powerlines	Not known
Adult Origin unknown	Sep 1999	At foot of electricity pylon below 'junction box'	Not known; very small rodenticide residue (see table 18)
3rd year Chilterns	Apr 2000 Chilterns	Found sick in garden	Wound at site of missing wing-tag, possibly result of infection; euthanased
2nd year Chilterns	Apr 2000 Chilterns	Found under powerlines	Not known, long dead when found
3rd year Midlands	Jun 2000 Midlands	Injured on runway of small airfield	Collision reported by pilot of light aircraft soon after take-off; bird found and subsequently euthanased (further incident in summer 2001 in Chilterns where pilot reported hitting kite but not confirmed)
1st year Chilterns	Sept 2000 Chilterns	Dead below electricity pole	No evidence of electrocution; evidence of trauma so possible collision but could have been as fell from pole
1st year Wiltshire	Oct 2000 Savernake, Wilts	At foot of electricity pylon with 'transformer box'	Found c.1-200m from nest - tail not full grown so probably died soon after fledging
2nd year? Yorkshire	Apr 2001 Yorkshire	Dead on edge of busy road	Injuries consistent with death by collision
4th year Chilterns	Apr 2001 Chilterns	Dead on railway	Collision with train; close to pheasant carcass on line on which had presumably been feeding
4th year Chilterns	May 2001 Chilterns	Dead on railway	Collision with train; same site as above, sibling of above bird (tags 19 and 20!) - also lead shot present (see table 21)

1st year Chilterns	Nov 2001 Chilterns	Dead on railway	Same site as 2 birds above and reported by the same railway worker; found highly decomposed between 2 tracks
1st year Midlands	Nov 2001 Midlands	Dead, suspended in hedgerow	Found hanging by radio-harness in hedgerow; not clear if this caused death or if it was placed in hedgerow after death

Table 20: Red kite incidents in England resulting from natural causes, 1989-2001

Age of bird (Calendar year) Origin	**Date found/ Location**	**Finding details**	**Probable cause of death – Comments**
Pre-release 1st year Chilterns	1991 Chilterns	Died in captivity before release	Avian pox/trichomonas
1st year Chilterns	Sept 1992 Chilterns	Found dead – no further details	Veterinary tests before release suggest trichomonas as likely cause of death
2nd year Chilterns	Jan 1994 Chilterns	Found sick and died in captivity	Aspergillosis - fungal infection common in stressed/poor condition birds
3rd year Chilterns	Dec 1994 Chilterns	Found dead – no further details	Abdominal cyst/tumour
2nd year Chilterns	Mar 1995 Chilterns	Found dead – no further details	Avian TB
3rd year Chilterns	Jan 1996 Chilterns	Found dead – no further details	Trichomonas infection which could account for poor condition and death of bird; later CEH analysis found lead in liver (see table 17)
Adult Captive origin	Nov 1996 Midlands	Found sick on ground by road; died in captivity	Starvation/water-shortage most likely cause of poor condition; seemed poorly adapted to life in the wild following previous period in captivity
Nestling Chilterns	July 1998 Chilterns	Found sick on nest - taken into captivity	Infection of eye/mouth; lost upper mandible and therefore not fit for release back into wild
6th year Chilterns	Feb 1999 Chilterns	Found injured on road	Died in captivity; aspergillosis may have pre-dated wing injury and so made collision more likely (see table 19)
Nestling Chilterns	July 1999 Chilterns	Found dead below nest	Nutritional bone disease possibly due to poor diet
Nestling Chilterns	July 1999 Chilterns	Found dead below nest	Fracture of pelvis possibly caused by fall
Recently-fledged Midlands	July 1999 Midlands	Found dead near nest	Several healed fractures; bleeding from wounds probably caused by predation when on ground; rodenticide residue (see table 18)
2nd year Chilterns	Mar 2000 Chilterns	Found injured; died in captivity 2 days later	Mycobacteriosis (avian TB)
Nestling Chilterns	July 2000 Yorkshire	Poor growth in release pens; euthanased	Nutritional/metabolic bone disease most likely cause of death
2nd year Midlands	Feb 2001 Midlands	Found dead inside shelter-belt	Abscess on crop resulting in starvation, possibly caused by trichomonas

Table 21: Red kite incidents in England involving shooting, 1989-2001

Age of bird (Calendar year) Origin	Date found/ Location	Finding details	Cause of death/comments
2nd year Chilterns	Jun 1994 Chilterns	Found dead in emaciated condition	Lead shot in buccal cavity, significance unclear
2nd year Chilterns	Apr 1995 Chilterns	Found injured	Fractured bones caused by shotgun wound; many pellets lodged in body and wings; rehabilitated and released in Midlands where bred successfully
2nd year Origin unknown	Jul 1996 Burnham Beeches, Bucks	Found injured	Pellets from shotgun lodged in tissues; rehabilitated and released in midlands
2nd year Chilterns	May 1999 Chilterns	Found injured	X-ray revealed shotgun pellets; rehabilitation unsuccessful; also rodenticide residue (see table 18)
2nd year Midlands	Apr 1999 Midlands	Dead in roost wood	X-ray showed single lead pellet in neck; either ingested or result of being shot
3rd year Chilterns	July 1999 Sopworth, Gloucs/Wilts	Found injured in garden	Shotgun pellets revealed by x-ray; rehabilitated and released in Chilterns, Aug 1999
4th year Chilterns	May 2001 Chilterns	Dead on railway	Killed by collision but lead pellets of 2 different sizes revealed by x-ray, so shot (probably on 2 separate occasions) and recovered in past

13.8 Further research

Even in cases where the ultimate cause of death is obvious from a post-mortem, it is often impossible to determine the underlying factors that eventually resulted in death. For example, a bird that is weakened by hunger or disease may take more risks when foraging for food and therefore become more vulnerable to collision or human persecution. Alternatively, a bird that is suffering from the sub-lethal effects of poisoning may be less able to find food and so become weaker and more susceptible to disease, or may be more sluggish when taking off and hence more vulnerable to collisions with vehicles. Determining the main threats currently faced by the red kite in England is not as straightforward as simply counting the number of incidents from the different causes in tables 17 to 21.

This is an area where further research would be desirable. In particular, it would be instructive to compare levels of rodenticides in birds killed by collision with vehicles or powerlines, with those killed by illegal poisoning, for example, where sub-lethal levels of rodenticide are unlikely to be an important factor. The Wildlife Incident Investigations Scheme currently only accepts tissues for analysis when there is a strong suggestion that the bird is likely to have been poisoned. There is therefore a lack of data on rodenticide residue levels in birds that may have been adversely affected by sub-lethal levels of rodenticide that made them more vulnerable to death from other causes.

14. Conclusions - prospects for population increase and range expansion

With its lack of specialist habitat requirements, generalist diet and tolerance of human disturbance, the red kite should be able to thrive in most areas of lowland England, despite the changes that have taken place since the species was last a regular breeder. The Midlands red kite project has been carried out in an area with a high proportion of intensively managed arable farmland and yet survival rates and breeding productivity have been high, allowing the population to increase to its current, self-sustaining, level.

Despite the success of the project, monitoring work has raised concerns about mortality factors relating to human activities. As is clear from the tables, a large majority of recorded red kite deaths are the result of such factors and there are particular concerns about illegal persecution and secondary rodenticide poisoning. It is one of English Nature's priorities to reduce the impact of these threats in order to aid the red kite's recolonisation of England and to help other species that are affected by the same problems.

It is apparent, particularly from monitoring in the Chilterns, that the red kite can thrive at high densities in lowland England and despite rapid population increases, the rate of spread to areas away from the release sites has been slow. Strong natal philopatry and the highly social nature of the red kite further limit the potential for spread. Only a very few isolated breeding pairs, well away from the nearest red kite population, have been found in England during the last decade. So far, these occurrences have shown no sign of resulting in the establishment of new populations. The young from such pairs often move away from the nest and join established populations, reflecting their social nature, rather than remaining in the nest area to breed (Carter *et al* in press). Further release projects may be useful in helping the process of recolonisation.

It has been estimated that if the current density of breeding red kites in the Chilterns core area (approximately 0.25 pairs/km^2) were to be replicated throughout lowland England, the English population alone would easily exceed 20,000 pairs, not far short of recent estimates for the total world population (Carter & Grice 2000). This figure will clearly not be reached for very many years, given the currently small populations and slow rates of spread. There is, however, no reason to suppose that it will not be achieved at some point in the future, particularly if the current threats from persecution and secondary poisoning can be managed.

15. Acknowledgements

We would like to thank all those people who helped to make the Midlands reintroduction project possible. Jose Lara Zabia and Maria Teressa Tarazona provided invaluable help in arranging for nestlings to be collected from central Spain, and permission to take birds was granted by the Junta de Castilla y León (Dirección General del Medio Natural). The Southern England Kite Group (Mick McQuaid, Nigel Snell and Peter Stevens) helped with the translocation of red kites within England, and Tony Cross and Nick Fox provided rescued young from central Wales. Ian Evans, Rod Hall, Karl Ivens, Charlie Rugeroni, Peter Stevens, Robert Thomas and Jonathan Wray all helped with the collection of birds for release.

The task of monitoring released birds and studying the subsequently re-established population was shared with John Cornell, Derek Holman, Karl Ivens, Momo Medina, Deborah Ottway and Robert Thomas. Peter Stevens and Will Dixon carried out radio-tracking in the Chilterns which helped to locate birds that had dispersed from the Midlands.

Roger Clarke's expertise was invaluable during studies of diet. Brian Cresswell, Robert Kenward, Sean Walls and Andrew Roy provided much useful guidance on radio-tracking. Chris Monk helped to set up a database of records from studies of radio-tagged and wing-tagged birds, from which, much information on survival rates, dispersal, home range and habitat-use was derived. David Parkin at Nottingham University and University Diagnostics Ltd. determined the sex of young red kites from blood samples.

Information on the main mortality factors currently affecting the red kite in England has been built up as a result of post-mortems carried out by Andrew Cunningham, Tracey Howard, James Kirkwood, Tony Sainsbury and Sue Thornton at the Institute of Zoology, London Zoo. Pesticide residues in red kite tissues were determined by analysis at the Central Science Laboratory and the Centre for Ecology and Hydrology, and Mark Fletcher (CSL), Richard Shore (CEH), Alastair Burn (English Nature) and Peter Karner (DEFRA) have provided much guidance on this subject.

The following people are also thanked for their involvement with the reintroduction project in recent years: Colin Crook, Katherine Davies, Kevin Duffy, Graham Elliot, Brian Etheridge, Richard Gregory, Steve Holliday, Julian Hughes, Duncan McNiven, Peter Newbery, Ian Newton, Duncan Orr-Ewing, Lorcan O'Toole, Jemima Parry-Jones, Guy Shorrock, Doug Simpson and Simon Wotton.

Last, but certainly not least, we are indebted to the landowners, gamekeepers and farmers who have supported the project by reporting their observations and allowing access to land for monitoring.

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ENGLISH NATURE

English Nature is the Government agency that champions the conservation of wildlife and geology throughout England.

This is one of a range of publications published by:
External Relations Team
English Nature
Northminster House
Peterborough PE1 1UA

www.english-nature.org.uk

Cover printed on Character Express, post consumer waste paper, ECF.

ISSN 0967-876X

Cover designed and printed by Status Design & Advertising, 2M, 2M.

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