



## 1. INTRODUCTION

The kestrel (common kestrel) is widespread throughout Britain and Ireland (Village, 2002), although numbers have decreased (Gibbons *et al.*, 1993; Greenwood *et al.*, 2003; Riddle, 2007). The British population may have declined by half since the early 1970s (Clements, 2008). British and Irish kestrels are partial migrants. In upland areas, some birds, mostly males, remain in their home ranges while others migrate south into lowland areas of Britain and Ireland, with a few reaching mainland Europe (Village, 1990). Kestrels breeding in lowland areas tend to be sedentary. Northern European populations are migratory, with birds moving into southern Europe and Africa for the winter (Village, 2002). Birds from countries bordering the North and Baltic Seas have been recovered in Britain and Ireland, particularly southeast England, in winter. Adult male kestrels are easily separated from females by their distinctive spotted chestnut back and blue-grey head and tail; females are predominantly brown, with varying degrees of grey on the rump and tail and barred upper plumage. Immature males gradually moult into the adult plumage in their second and third year (Cramp & Simmons, 1980). Juveniles cannot be distinguished easily in the field from females. About 60% of kestrels breed in their first year (Wyllie & Newton, 1999), with more young birds breeding in years when their main prey, voles, are more abundant.

For further information on the biology and ecology of this species, Village (1990) provides a comprehensive account. Riddle (1992) describes fieldwork techniques in detail.

## Annual cycle

Breeding Activity	Peak Period	Range	Duration (days)
Occupation of home range; establishment of home ranges that are not continuously occupied		All year in lowland breeding territories; late February to late April in vacated breeding territories; August to October for winter territories	
Territorial display		All year	
Courtship		March to May	
Egg laying	Late April to mid-May	Late March to early June	6 to 8
Incubation	Late April to early June	Mid-April to early July	26 to 34
Hatching	Late May to mid-June	Early May to late July	
Young in nest	Late May to early July	Early May to early August	28 to 35
Fledging		Early June to early August	
Juvenile dispersal		July to August	

## 2. HABITAT, HOME RANGE, NESTS AND BREEDING

### 2.1 Habitat

Kestrels breed in almost any habitat that holds sufficient prey (small mammals or birds) and nest sites, including urban, industrial and suburban areas, parkland, open moorland with trees and crags, upland grassland, young conifer plantations, heaths, wetlands with trees, all types of farmland, quarries, saltings and dunes. They tend to avoid large, dense forests, treeless wetlands and montane areas. In Britain and Ireland, most nests are below 480 m ASL (Village, 1998) but nests are found at higher altitudes in mainland Europe. Winter territories are in habitats similar to those used for breeding.

### 2.2 Home range

During the breeding season, home ranges overlap, the degree of overlap increasing with distance from the nest. Home range size varies from less than 1 km<sup>2</sup> to over 10 km<sup>2</sup> (Village, 1990) and is related to prey abundance; when prey populations are high, kestrels have smaller home ranges (Village, 1982, 1990). Breeding densities of 12–32 territorial pairs km<sup>-2</sup> were found in three study areas in Britain (Village, 1990). The nesting territory is vigorously defended by the male against potential predators and other kestrels (Village, 1998), although he may solicit an intruding female during courtship. Individual females vary in their response to intruders. They are generally aggressive early in the breeding cycle; aggression declines prior to laying and during incubation and then increases again after the young hatch (Wiklund & Village, 1992). Females are more aggressive if they have a large brood. The extent of the area around the nest site that is defended is highly variable. Kestrel nest sites are normally well dispersed but they may breed in close proximity if there are few suitable nest sites but abundant prey in a given area. In extreme cases, small colonies will form (Village, 1990; Bustamante, 1994), but kestrels will still establish a nesting territory and defend it even within these groups. Village (1990) reports distances between nests of 40 m to over 5 km; in a farmland study area less than 7% of pairs nested within 200 m of their nearest neighbour, whereas nearly 40% of pairs in a grassland area nested within 200 m. More instances of nests in close proximity are described by Cramp & Simmons (1980). Winter home ranges are defended and exclusive (Village, 1990). They can be held either by local resident birds and/or by immigrants wintering in the area. In some areas where pairs are sedentary, the male and female may each hold and defend a territory (Village, 1990; Shrubbs, 1993a).

### 2.3 Nest sites

Kestrels are catholic in their choice of nest site. They can be tolerant of human activity and nest in close proximity to people. Kestrel nests are found on rock ledges on crags or in quarries, in tree holes and in nest boxes (Shrubbs, 1993b). They may also use the old stick nests of other birds, mainly those of carrion and hooded crow, but the nests of buzzard, magpie and sparrowhawk are used occasionally and the use of nests of golden eagle, raven, jay, rook, woodpigeon and grey heron has also been recorded. Nests may also be located on a wide variety of buildings and other human constructions that provide sheltered sites, including churches, barns, straw stacks, bridges, cranes, electricity pylons, disused chimneys, limekilns and window ledges in high rise flats (Village, 1990; Riddle, 1992). In addition, nests have been found on the ground in long heather and even in rabbit burrows (Village, 1990), particularly on Orkney (Balfour, 1955).

Kestrels will readily use nest boxes (Riddle, 1992; Valkama & Korpimäki, 1999; Fargallo *et al.*, 2001), if they are placed near grassy areas with good numbers of voles. Ideally two boxes should be erected close together, as one box may be used by owls.

## 2.4 Nests

Kestrels do not build a nest but will scrape a depression in the nest substrate, for example in hole nests or in the collapsed nest cup of an old crow nest. The depression may be lined with small pieces of vegetation nibbled by the incubating female from the immediate vicinity of the nest. Where the lining of an old nest remains intact, or there is little lining, kestrels will lay their eggs in the existing cup.

## 2.5 Clutch size and incubation

Most British and Irish kestrels complete laying by mid-May, and in years of favourable weather and prey abundance, many will lay in April or even March. Eggs are normally laid at 2-day intervals and clutch size is related to laying date. Early clutches are larger (5–6 eggs), than later ones (3–4 eggs; Cavé, 1968; Village, 1990, 1986, 1989; Riddle, 1987) and clutches of 7–8 eggs can be laid in good vole years (Riddle & Sheppard, 1999). The BTO Nest Record Scheme gives an average clutch size of 4.7 ( $n=1,873$ ). In areas where the vole population is cyclic, kestrels lay larger clutches in good vole years than in poor ones (Cavé, 1968; Village, 1986; Shaw & Riddle, 2003). Kestrels sometimes relay if they fail early in the breeding cycle. Incubation normally begins after the third egg is laid, although it may start earlier (Beukeboom *et al.*, 1988; Village, 1990) and lasts 26–34 days (Village, 1990). The male delivers food to the female during courtship and incubation (5–13 items per day). Incubation is carried out almost entirely by the female who leaves the nest only briefly for feeds (Village, 1990), during which time the male will incubate. Desertion of clutches occurs more frequently in wet weather (Village, 1998).

## 2.6 Brood size and fledging

Hatching can be synchronous or asynchronous, sometimes taking 4–5 days. Young kestrels are brooded by the female until they are about 10 days old (Village, 1990). The male provides food for the female who tears up prey to feed the chicks. After she has stopped brooding, the female may also hunt to provide food for the young and continues to feed the young. An average of 13 food items are delivered to broods per day, although this number may be halved in poor weather; and delivery rates can reach 19–22 items per day (Village, 1990). The feeding rate generally decreases in the evening. Chicks fledge after 28–35 days and are fed by their parents for a further 2–3 weeks, after which they begin to disperse from nesting territories. The majority of breeding failures take place at the prelaying or clutch stage (Riddle, 1993) and success rates are generally high once the eggs have hatched, although individual chicks may die (Village, 1990).

# 3. SURVEY TECHNIQUES

**CAUTION** *Kestrels should not be disturbed in their nesting territories while pairs are still displaying as this may cause the birds to move location. Care should also be taken while birds are likely to be laying. Nesting areas should be observed from a discreet distance during these times. Avoid visiting the nest after the chicks are three weeks old because they are prone to fledge prematurely from this age. If nest inspection visits require climbing, then appropriate health and safety precautions should be taken (see Section 7.10 of Introduction).*

## 3.1 Breeding season visit schedule

The species is listed on Schedule 1 in Northern Ireland and the Isle of Man. To establish occupancy and the presence of a breeding pair, it is recommended that all four visits are made (as detailed below). However, if time is limited and a home range appears to be unoccupied on the basis of the first two visits, then further visits to that home range can be omitted. Kestrels are most easily located when displaying early in the breeding season and around the time of fledging when they are active and noisy. Care must be exercised to avoid disturbing pairs while

they are displaying and laying; if there is any uncertainty over the stage in the breeding cycle, Visit 2 should be delayed. Broods that have fledged early may start to disperse by late July.

Visit 1	Late March to May	To check for occupancy
Visit 2	May	To locate active nests
Visit 3	June	To check for young
Visit 4	July to August	To check for fledged young

## 3.2 Signs of occupancy

### 3.2.1 *Locating home ranges*

Kestrels that are intending to breed begin to establish nesting territories from March to late April (Village, 1986). Fieldworkers should search suitable habitat in study areas for occupied nesting territories from late March onwards. Kestrels will alarm if disturbed or if responding to other raptors or corvids entering the nest area. They may also be seen displaying over the nesting territory. Display flights involve both the male and female circling and chasing, often high into the sky; the male repeatedly dives at the female in mock-attacks and the female rolls sideways at the last moment to avoid collision (Cramp & Simmons, 1980). If the female perches, the male often continues to mock-attack her. Pairs may also 'play' with objects (e.g. play with sheets of cardboard in the air has been noted; Cramp & Simmons, 1980). A shivering or 'winnowing' flight is sometimes used when approaching the nest site and is a good indication of territorial behaviour. It is particularly frequent during the period immediately before laying and is also used for territorial defence (e.g. if a human approaches an active nest).

No attempt should be made to locate the nest site itself at this early stage in the breeding cycle, as disturbance may cause the birds to move away. Many nesting ranges are traditional and are occupied in most years, while others are only occupied in years when prey is abundant (Riddle, 1992).

### 3.2.2 *Locating roosts*

Kestrel roosts are found on crags, buildings and in trees. Active roosts will have fresh faecal droppings and down, with fresh pellets on the ground below the roost. The white droppings often make roosts conspicuous. Moulded feathers will also be found and these are the key to linking the other signs to kestrels rather than to other species. Roosts can be found by searching the nesting territory or home range systematically for suitable sites but this should be carried out only after incubation is well established.

### 3.2.3 *Recognition of signs*

Kestrel pellets are usually very light, grey and often laterally compressed and tapered at one end (length 20–40 mm; width 10–25 mm; Brown *et al.*, 2003). They consist mainly of fur/feathers and frequently contain the bones of small mammals (the main prey). The remains of insects and birds may also be present. Kestrel pellets can be variable and difficult to separate from those of other raptors, however, and identification should be confirmed by the presence of other signs. Kills of small mammals are generally consumed whole and small birds may be plucked some distance from the nesting site.

### 3.2.4 *Evidence of occupancy*

The criteria for probable breeding (See 3.3 below) can be used as evidence of occupancy. Occupancy should preferably be based on observations of birds on at least two occasions

during the breeding season. Not all kestrels occupying winter territories remain in an area to breed, so multiple observations suggesting occupancy in winter should not be taken later as evidence for breeding occupancy.

### 3.3 Evidence for breeding

Gilbert *et al.* (1998) define confirmed, probable and possible breeding as follows:

CONFIRMED BREEDING	<ul style="list-style-type: none"><li>• A nest containing eggs or young is found</li><li>• An adult is seen carrying food for the young</li><li>• A used nest or eggshells are found (occupied or laid within the survey period)</li><li>• Recently fledged young are found</li></ul>
PROBABLE BREEDING	<ul style="list-style-type: none"><li>• A permanent territory is presumed through observations of territorial behaviour on at least two different days separated by a week</li><li>• Agitated behaviour or anxiety calls are given by the adults</li><li>• Courtship and display behaviour are witnessed</li><li>• A pair of kestrels is seen in suitable nesting habitat in the breeding season</li></ul>
POSSIBLE BREEDING	<ul style="list-style-type: none"><li>• A kestrel is observed in April and/or May in possible nesting habitat</li></ul>

Fieldworkers carrying out intensive studies may wish to confine the definition of breeding pairs to those where breeding is confirmed.

#### 3.3.1 Locating active nests

Once occupied nesting territories have been located, the areas should be searched systematically for nests. An active nest may have pellets, or occasionally moulted feathers, below it, and down on the edge. Incubating kestrels may not flush easily, especially during late incubation, and if the presence of a sitting bird cannot be detected through watches from a distance it may be necessary to visit the nest to check the contents (taking appropriate care if climbing is involved, Section 7.10 of Introduction). Any nesting territories where the birds are known to have failed early in the season, or that were apparently unoccupied during Visit 2, should be checked late in the season (June/July) in order to detect any relays or late breeding attempts.

Call playbacks may also be useful in locating kestrel nest sites. Salvati *et al.* (2000) used this technique to locate occupied nests in holes in Roman ruins and buildings in central Rome and suggested playback may be integrated with other techniques in locating breeding pairs. It may be particularly useful in separating neighboring sites in dense populations or in surveying large areas rapidly. Disturbance during such surveys should be minimised by using playback only in the early part of the breeding cycle (during incubation and brooding). Each site should only be surveyed twice. Playbacks should not be used to locate fledged young as they do not respond and may be disturbed if adults respond to calls.

#### 3.3.2 Evidence for fledging

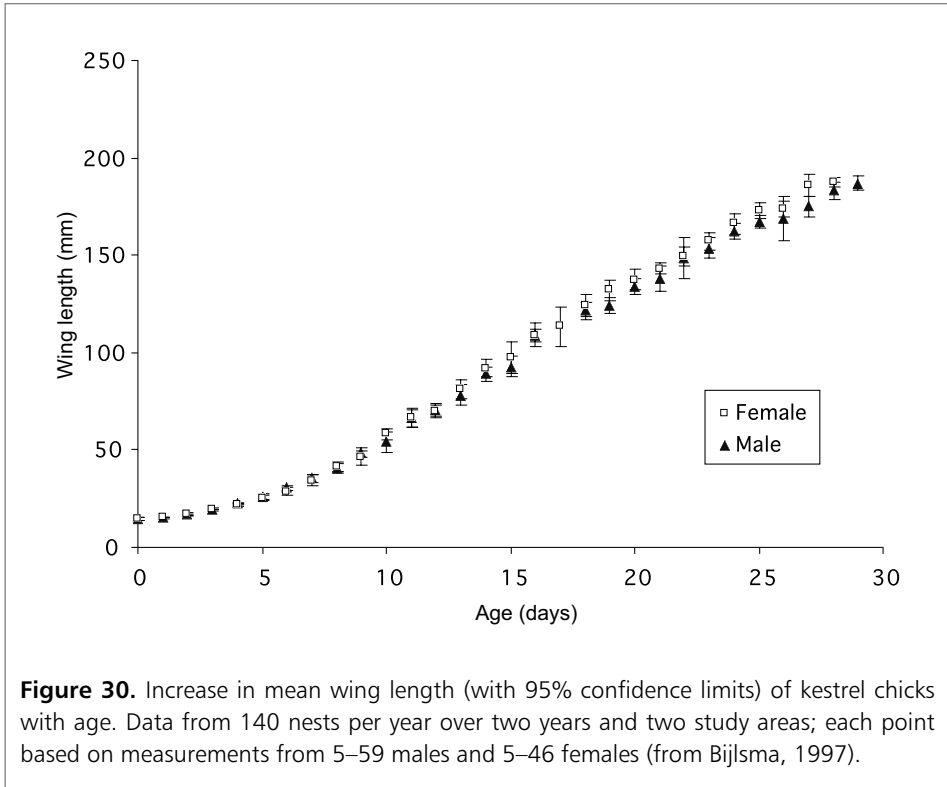
Counts of large young in the nest can be used as an estimate of fledged brood size because their survival rates are high. Fledged young will remain in the vicinity of the nest for 7–14 days. They can be located by their calls and counted at this stage. For large broods, it can be difficult to keep track of individual young as they move around (Riddle, 1992) and a minimum figure for the number of fledged young should be recorded.

### 3.4 Evidence for non-breeding

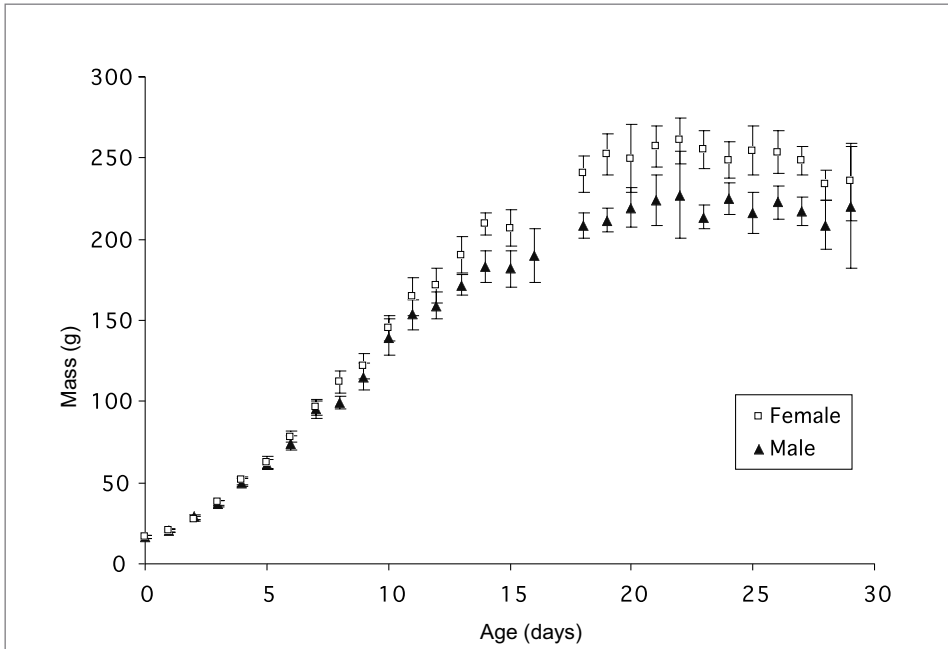
Not all kestrel pairs occupying home ranges lay eggs each year. Sedentary pairs are more likely to miss breeding than partially migratory pairs or migratory birds (Village, 1990, 1998). Non-breeding can be more common after cold winters (Village, 1998) and may be more frequent in areas where vole numbers are low (Village, 1990). If there is no evidence of an active nest or fledged young, despite several visits to a previously occupied nesting territory at appropriate times, this provides good evidence of non-breeding. The members of failed pairs often remain within the home range but territorial and courtship behaviour declines early in the breeding season. Pairs that are disturbed prior to egg laying may move elsewhere to breed and appropriate visits should be made later in the season to check for relays.

### 3.5 Ageing and sexing young

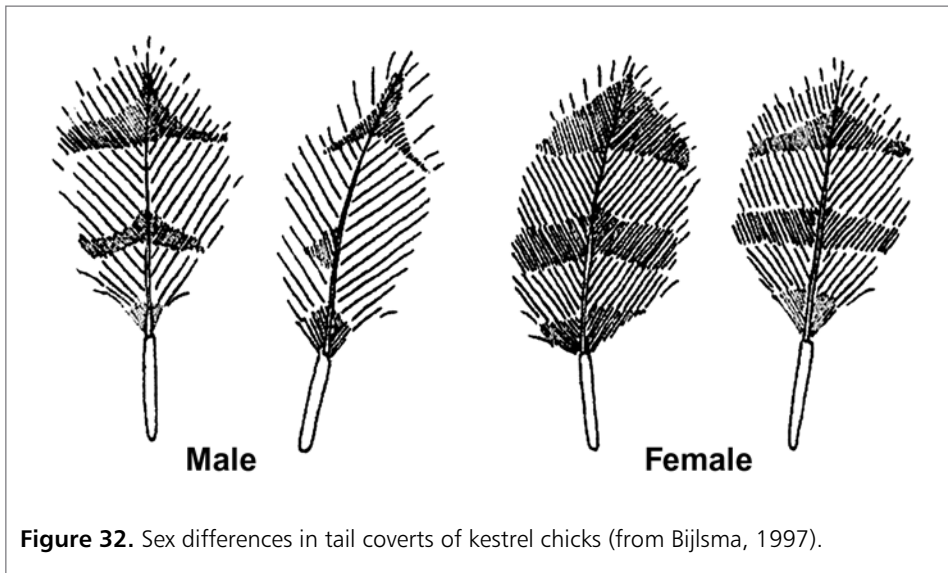
Chicks can be aged approximately from their wing length (Dijkstra *et al.*, 1990; Bijlsma, 1997; Figure 30). Wing length cannot be used to sex kestrels, however, as the measurements of males and females overlap considerably. Mass (Figure 31) can be used in conjunction with the colour and pattern of the upper tail coverts (Figure 32) to sex many young. From the age of 20 days (wing lengths >138 mm), females have brown upper tail coverts with broad, dark-brown bands. Males have greyish tail coverts with smaller bands. Some chicks cannot be sexed by these means, as their upper tail coverts do not follow this pattern but are brown-grey. Mass (Figure 31) can also be used for approximate ageing, if the sex of chicks has been established using the tail coverts.



**Figure 30.** Increase in mean wing length (with 95% confidence limits) of kestrel chicks with age. Data from 140 nests per year over two years and two study areas; each point based on measurements from 5–59 males and 5–46 females (from Bijlsma, 1997).



**Figure 31.** Increase in mean body mass (with 95% confidence limits) of kestrel chicks with age. Data from 140 nests per year over two years and two study areas; each point based on measurements from 5–62 males and 5–47 females (from Bijlsma, 1997).



**Figure 32.** Sex differences in tail covers of kestrel chicks (from Bijlsma, 1997).

## 4. SURVEYS OUTSIDE THE BREEDING SEASON

A winter territory is occupied if a bird is seen in a given area on several occasions. Winter territories can be delineated by mapping observations of kestrels during regular visits to the study area from the end of October until February (when breeding birds will begin returning). A note of the age and sex of each bird observed should be made and behaviour recorded. Such work can provide an estimate of the winter population size in a given area.

An index of wintering kestrel abundance can be obtained by carrying out counts of birds observed from defined survey routes (preferably randomly selected or at least representative of habitats in the area to be covered), either on foot or by car. Roadside counts are used widely in North America to measure the abundance and sex ratios of wintering American kestrels (Village, 1990). In his own studies in lowland farmland, Village set an 80 km route in each area and drove it three times a month from October to April to obtain counts of kestrels seen. Thus, observers should cover a fixed route in a set time, and record observations of kestrels and the approximate distance of each bird from the 'transect' line (weather conditions should also be noted). The data collected could be used as an index of change in numbers between years. In Britain and Ireland, such survey work would be best undertaken between mid-November and late February, to exclude irregular influxes of immigrants during passage periods, but surveys should be carried out at approximately the same time each year, as counts will decline during the winter due to mortality and emigration (Village, 1990).