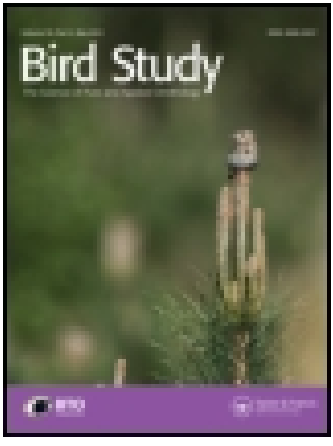

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Breeding, Mortality and Movements of Kingfishers

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Breeding, Mortality and Movements of Kingfishers

by Robert Morgan and David Glue

The Kingfisher has an extended breeding season (more than half the year) and each pair needs to raise one-and-a-half young annually on average to compensate for the high juvenile and adult mortality rates, which exceed 75%. Movements of British and Continental birds are compared.

THE BREEDING DISTRIBUTION OF THE KINGFISHER *Alcedo atthis* covers much of Europe, Asia and Africa, excluding the tundra and desert climatic zones (Voous 1960). It is a widespread species in Britain and Ireland, though local in south Scotland, and absent from the west Scottish islands and most of the Highlands (Parslow 1967, Sharrock 1976). The information collected by the British Trust for Ornithology's Nest Record and Ringing Schemes is now sufficient to describe the annual cycle of the Kingfisher in this country in some detail. The 173 nest record cards contributed between 1942–74 give details of breeding habitats, nest sites, breeding season, clutch and brood sizes and nesting success; and the 222 ringing recoveries reported between 1910–74 permit movements and annual mortality to be described.

BREEDING HABITATS

Kingfishers breed near water, where there is a readily available source of food. Of the nest record cards 80% refer to lowland Britain below 122 m (400 ft) a.s.l., with only the counties of Cheshire and Lancashire recording over 183 m (600 ft). The nest is most commonly situated in the bank of a stream or tributary of a major watercourse (68 nests), less often in the main river bank (41 nests), and, increasingly today, in the banks of various kinds of ballast pits (26 nests). Less common sites include ditch banks, reservoir embankments, and the sides of canals, lakes and farmland pools. On streams lacking suitable banks tree-root sites may be important locally; such are occupied regularly in parts of Oxfordshire (Dr B. Campbell, pers. comm.). Occasionally, nests may be some distance from water (Table I), and one suspects that others in similar places may well be missed.

TABLE I. KINGFISHER NESTS AT A DISTANCE FROM WATER

Distance from water	*Habitat and nest site*	*County*
69 m (225 ft)	Roots of fallen tree on farmland	Hampshire
229 m (750 ft)	Lime slurry pit near sugar beet factory	Cambridgeshire
297 m (975 ft)	Sand-pit in young forestry plantation	Norfolk

Unusual sites include holes in a wall, one beneath a bridge, and one in a rotten stump used successfully for several years on Farlington Marshes, Hampshire (Tubbs 1952). Concrete tunnels in canal banks have been used, as at Newport in Gwent. Eastman (1969) has amply demonstrated the possibilities of constructing relatively soft, excavatable banks where the paucity of natural sites may limit breeding, but the provision of artificial nest sites has not been fully explored.

Kingfishers prefer vertical or overhanging banks; those sloping away from the river are not normally chosen. In localities where suitable banks of sand or earth are plentiful the same hole is rarely used in consecutive seasons, although a particular stretch of river may be favoured annually. Natural breaks in the watercourse, such as small bays, quiet backwaters, stream junctions, bends in the river and lake outlets are often chosen. Occasionally the burrows of Sand Martins *Riparia riparia* and Water Voles *Arvicola amphibius* are enlarged, but the Kingfisher's final product can usually be identified by its circular section, and late in a successful season by the dark slime and excrement that trickles from the hole.

Nest excavation is undertaken by both sexes. Early attempts are often unsuccessful and as many as six tunnels may be partially excavated before the nest is completed. To some degree the nature of the substrate determines the length of the tunnel, and although softer sections are normally chosen, comparatively hard sand, clay and flint-strewn earth can be excavated successfully, though such burrows may follow a tortuous route. The length of 35 burrows varied between 15–94 cm (6–37 ins), with 75% measuring from 31–90 cm (12–36 ins). These figures may well be biased against larger tunnels, since up to 137 cm (54 ins) was reported by Clancey (1935). The tunnel is usually excavated at right-angles to the bank, and is normally inclined at about 30° towards a bulbous nest chamber at the end.

TABLE II. HEIGHT OF KINGFISHER NESTS ABOVE WATER

Metres	*Feet*	*No. of nests*
0–0.6	0–2	6
0.7–1.2	2–4	53
1.3–1.8	4–6	49
1.9–2.4	6–8	12
2.5–3.0	8–10	4
3.1–6.1	10–20	11
6.2–9.1	20–30	1

With few exceptions the nest hole is excavated within half a metre of the top of the bank, secure from the risk of flooding during spring spates. The height above water varies (Table II) though the majority are from $\frac{1}{2}$–$1\frac{1}{2}$ m (2–6 ft); the extremes were 15 cm (6 ins) in a reservoir bank and 9.1 m (30 ft) in a quarry face. The nest entrance is usually readily visible, but may be concealed by trailing ivy and grasses, or positioned among the roots of a tree.

BREEDING SEASON

Kingfishers have an extended breeding season; of the 146 cards giving details of time of breeding, the earliest and latest dates for the onset of laying are 1 March and 24 July (Figure 1). Eggs have even been recorded in the last week of August (Murdoch 1908). A clutch started as late as the last week in July would still have young in the nest until the second week of September. Figure 1 indicates that two broods are normal, and some pairs even attempt a third. Almost half of the records refer to nests started in April, when most pairs are making their first attempt of the season. Later, a falling-off in nest recording, as well as the more luxuriant growth of vegetation, may lead to fewer second and third attempts being located. However, the cards show that if the first attempt is successful the second will most often be in the same burrow or close by.

Successive attempts were in the same burrow in 11 out of 15 cases. In two of the four instances where a new tunnel was used, young from the first brood were still being fed when excavation started. Only three cards refer to successive nesting attempts when the first failed, perhaps because birds move away to new sites before starting afresh. One was a second attempt in the original tunnel, after young of the first had died aged ten days. New tunnels were used in the other two cases; one is of interest because it refers to a new effort in the tunnel used for the first (successful) brood, after an intervening abortive attempt in a tunnel which was enlarged by humans. On another occasion a new nest chamber was dug for the second clutch, but the pair eventually returned to the original tunnel; a similar experience was recorded by Rivière (1933).

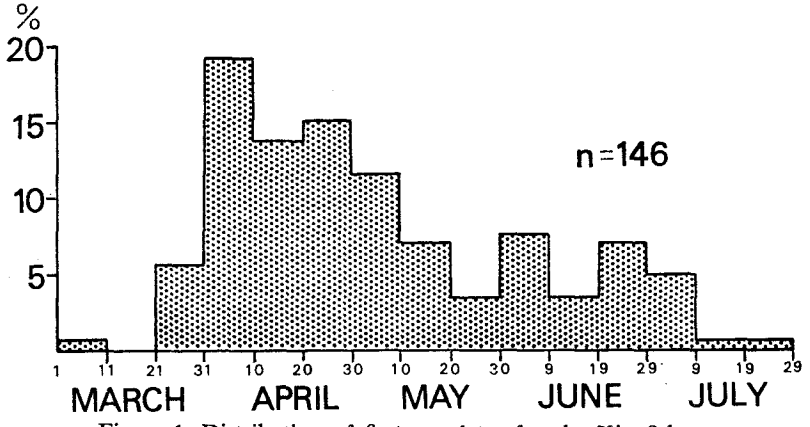

Figure 1. Distribution of first-egg dates for the Kingfisher.

Clutch and brood sizes

Table III gives information on Kingfisher clutch and brood sizes from the nest record cards; cards were used in the clutch size analysis if they satisfied the criteria laid down by Newton (1964). The sample sizes for clutch and brood are small owing to the difficulty of counting eggs and young accurately at the end of a long, narrow tunnel. The range of clutch size is between three and seven eggs (mean 6.29), with the latter by far the most frequent. One must be cautious, however, because Clancey (1935) records that incubating birds have been known to push out fertile eggs accidentally when leaving the tunnel. It is unusual for the largest recorded clutch size to be also the most frequent, but it should be noted that Witherby *et al.* (1938) record up to nine or ten eggs for this species.

Because of the difficulty of counting the young which actually leave the nest, the number surviving to 18 days or more (approximately three-quarters of the fledging period) is taken as the brood size (Table III).

TABLE III. KINGFISHER CLUTCH AND BROOD SIZES

	Number in nest						
	2	*3*	*4*	*5*	*6*	*7*	*Mean S.E.*
Clutches	–	1	1	4	5	17	6.29 ± 0.205
Broods	1	3	4	6	6	6	5.19 ± 0.288

Nesting success

Nesting success was calculated using the method described by Mayfield (1961), which makes the best use of the fragmentary information found on many nest record cards. Mayfield uses the term 'exposure', the number of nests lost varying with the number of nests in the sample, and with the number of days that each is under observation. The unit of exposure used in this analysis is the 'nest-day' (one nest under observation for one day). During the incubation period 13 nests were lost in 820 nest-days' exposure. The failure rate is therefore $13/820 = 0.016$ nests lost per nest-day. During the fledging period seven nests were lost in 1,237 nest-days' exposure, giving a failure rate of 0.006 nests lost per nest-day.

The probability of survival of nests with a failure rate r for a period of days d is $(1-r)^d$. During incubation (20 days) the probability of survival is therefore $(1-0.016)^{20} = 0.724$, and during the fledging period (25 days) it is $(1-0.006)^{25} = 0.0860$. The probability that Kingfisher nests will survive both the incubation and the fledging periods is $0.724 \times 0.860 = 0.623$ or 62.3%.

Failures recorded during the incubation period were mainly due to human disturbance, people either taking the eggs or enlarging the tunnel (eight records). One interesting record was of a Mole *Talpa europaea* having passed through the nesting chamber. A further six cards recorded destruction of the tunnel. The Kingfisher is probably more susceptible than any other species to the improvement of land drainage on lowland rivers. The extended breeding season means that nests are at risk in all but five months of the year. The hazards to a nesting Kingfisher include damage to banks by heavy machinery carrying out drainage work, and the grading of banks which removes suitable nest sites altogether. Apart from affecting breeding in this way, the elimination of trees and bushes from the river-side may remove necessary fishing perches from long stretches of the stream.

During the fledging period three instances of nests being dug out by boys or animals were recorded. Two records are of interest: one refers to dead young below a nest entrance, and the other to a territorial fight between rival males. Clancey (1935) noted that when Kingfishers are reasonably spaced during the breeding season little attention is paid to territorial rights, but when they are in close proximity to one another fighting is frequent. He recorded three occurrences of eggs being destroyed by rival pairs, and one instance of young being left to die, most probably after the parents had been chased away in a territorial dispute. Kingfishers can be very aggressive towards each other, and the young are not tolerated in the territory for long after leaving the nest.

MORTALITY

Kingfisher annual mortality was estimated from recoveries of birds ringed up to 1970, using the method described by Lack (1943). The longest-lived individual was ringed in July 1964 and was found dead four and a half years later in January 1969.

Table IV shows that mortality is high with three-quarters of the population dying each year (note that standard errors are large). Assuming the sex ratio to be equal, this means that 76 young must survive to breed for every 100 Kingfishers at the start of the year, in order to maintain population stability. The trapping of breeding adults originally ringed as nestlings shows that Kingfishers are able to breed when one year old (Brown 1934). Kingfishers lay fairly large

TABLE IV. KINGFISHER MORTALITY

	Recovery year after ringing				*Mortality*	*S.E.*
	1	*2*	*3*	*4*		
First year mortality (ringed as *pulli* only)	16	4	1	0	77.8%	7.99
Average annual adult mortality (ringed as *pulli* and full-grown)	25	5	1	1	76.2%	6.57

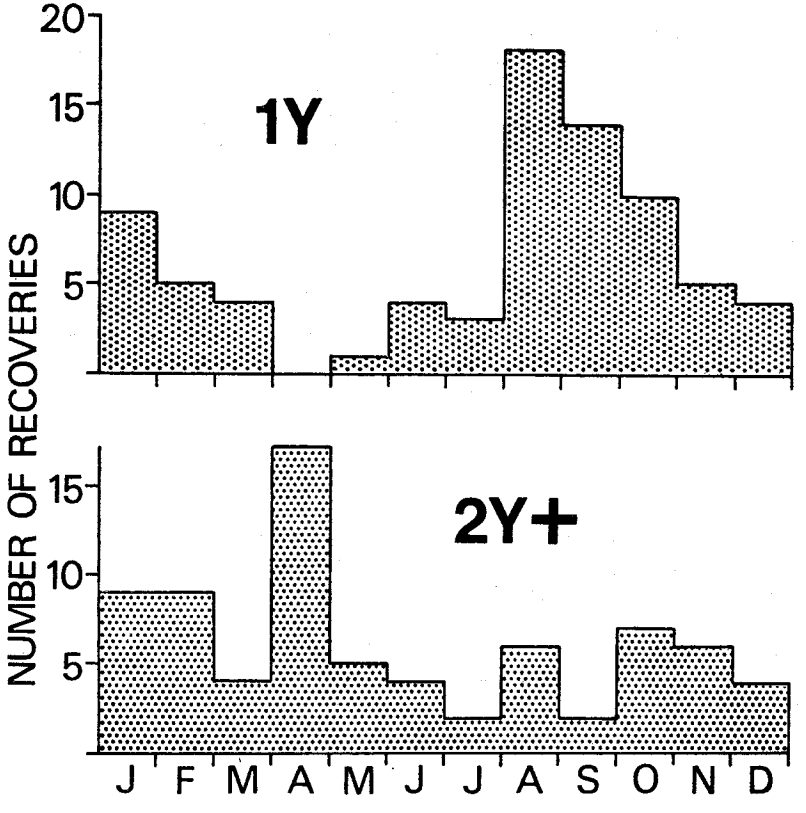

Figure 2. Pattern of seasonal mortality in first-year and older Kingfishers from ringing recoveries.

clutches, and rear over five young in a successful nest. Most pairs probably attempt two broods per season, and 62% of nests rear young. This should produce an average of 6.5 young per pair per year. Only about a quarter of these young birds survive to their first breeding season, which leaves one and a half young per pair to make good the high loss (76%) of adult birds. At this rate of recruitment Kingfishers are able to recover quickly from heavy losses inflicted by severe winter conditions.

Seasonal pattern of mortality

Almost half of the 152 Kingfisher recoveries giving information on the month when death occurred refer to first-year birds (the first year ending on 31 March), and half to second-year and older birds. However, these figures should be treated with caution as the ageing characters have been shown to be unreliable in some cases. Only recoveries of dead birds were considered, excluding those recorded as 'long dead' (see Figure 2).

The peak months for first-year mortality are August and September, when 61.5% of recoveries are reported. These are clearly the critical months for inexperienced juveniles which have left the parental territory. Constant wetting of the feathers is thought to be a cause of considerable mortality (Eastman 1969).

The other peak is in January, and the winter period also accounts for much adult Kingfisher mortality. In severe winters when frozen waters prevent fishing the Kingfisher may suffer heavy losses through starvation. Alternatively, birds may undertake movements to other mainly coastal areas which remain unfrozen. Dobinson and Richards (1964) summarised the results of a questionnaire sent out to discover the effects of the severe winter of 1962/63 on bird-life in Britain. No Kingfishers were recorded after January 1963, and this species was generally agreed to be the worst affected, most reports referring to total extermination, or at best severe losses. The only area not so badly affected was the Hampshire/Dorset border. A survey of the Kingfisher population in Wales revealed a reduction of 85% during the same winter (Smith 1969). However, subsequent records show a fairly rapid recovery, as in the London area (Meadows 1972 a, b). Venables and Wykes (1943) documented the Kingfisher recovery on the Thames following the severe 1939/40 winter, showing a rapid return of birds over the succeeding two years.

In contrast to the autumn peak for juvenile mortality, adult Kingfishers are most commonly reported dead in April, a time of stress associated with the onset of the breeding season and the establishment and defence of territories.

TABLE V. MAIN CAUSES OF DEATH AS SHOWN BY KINGFISHER RINGING RECOVERIES

	1st year	*2nd year and older*	*Total*	*%*
Found dead	33	31	64	42
Injured, dying	9	4	13	9
Roads	12	10	22	15
Predators	4	9	13	9
Windows	10	2	12	8
Netting	3	3	6	4
Wires	2	3	5	3
Cold weather	1	4	5	3
Other causes	7	4	11	7
	81	70	151	–

Table V shows that 42% of the 151 Kingfisher recoveries refer to birds simply 'found dead'. Traffic, or at least 'found dead on road' is the most common of the known recovery circumstances; 'found injured', falling victim to a predator (especially cats), and colliding with windows accounts for the majority of the remainder. Other causes of recovery include five birds caught in netting – at trout

hatcheries and in a garden. Another bird was tangled in a fishing line. One extraordinary recovery refers to a Kingfisher drowned in a jar of 'tiddlers' on the river bank. Persecution by man, especially for the plume trade but also by fishermen, as carried out in the nineteenth century, is no longer a serious threat to the species.

The Kingfisher is at the end of a food chain and is thus exposed to any contamination which may affect the water in which its fish are caught. In some areas such as southern Scotland the species is thought to be decreasing due to river pollution (Parslow 1967). This is certainly an important threat and one body tested for toxic chemicals was found to contain 'exceptionally high' concentrations of DDT, DDE, dieldrin and PCB* in its liver (Mead 1968). Meadows (1972) considered that the slower recovery rate of Kingfishers after the severe winter of

*PCB = polychlorinated biphenyl, a chemical pollutant from industry.

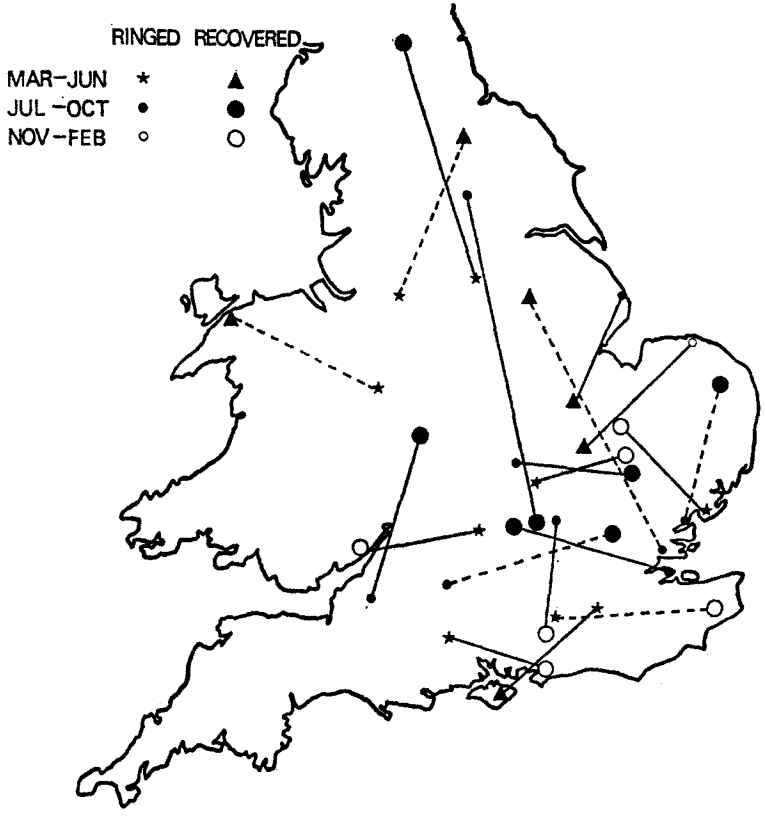

Figure 3. Kingfisher recoveries over 64 km (40 miles) from the place of ringing within Britain.

1962/63 on the River Lea in the Lower Thames, compared with the Upper Thames catchment area, was due to the higher rate of pollution in the smaller tributaries of the Lea. The sources of the pollution were equally distributed between agriculture, industry and the local authorities.

MOVEMENTS

Almost two-thirds of the Kingfisher recoveries within Britain refer to movements of less than 9 km (5.6 miles) (Table VI). However, long-distance movements of up to 250 km (155 miles) have been recorded, mostly in the autumn (Figure 3). The recoveries show no apparent preferred direction in autumn, and it seems likely that this is a period of general dispersal with young birds moving away from the parental territory. There are only six recoveries over 64 km (40 miles) during the period November–February, and four of these are birds moving to the coast; in addition, one bird ringed on the coast during November was subsequently recovered inland in April. Movements to the coast depend greatly on the severity of the winter. There are two recoveries of birds ringed during one breeding season and recovered a considerable distance away during the next.

TABLE VI. DISTANCES TRAVELLED BY KINGFISHERS RINGED IN BRITAIN (ALL RECOVERIES, 1910–74)

	1st year		*2nd year and older*	
Km	*no.*	*%*	*no.*	*%*
0–9	72	63	57	59
10–49	29	25	22	23
50–99	10	9	8	8
100 +	3	3	7	7
Overseas	1	1	2	2
	115		96	

British Kingfishers do not regularly move as far as some continental populations are known to do. Czechoslovakian birds, for instance, ringed during the breeding season, are recovered up to 1,500 km (900 miles) to south and west on the Mediterranean and even the Atlantic coasts (Mead 1969). French Kingfishers also undergo long-distance movements (Erard 1970), many spending the winter in Spain, while birds from farther north and east regularly move into and through southern France. The British population is not isolated and there are two recoveries of birds ringed in Britain being recovered in France: one representing a movement of 430 km (267 miles), and the other 505 km (314 miles). There is also one in Belgium (Figure 4) involving a movement of 555 km (345 miles), the longest distance known to have been travelled by a British Kingfisher. There is one recovery indicating movement in an opposite direction, from Brittany to North Wales.

In France many autumn movements, and all but one of the winter recoveries, are to the coast. Birds from the northwest move along the Atlantic coast or to northern Spain. Birds from the northeast and east move south and southwest, and it seems likely that birds travel in a north–south direction following the Rhône Saône corridor. The great delta area of the Camargue where the River Rhône

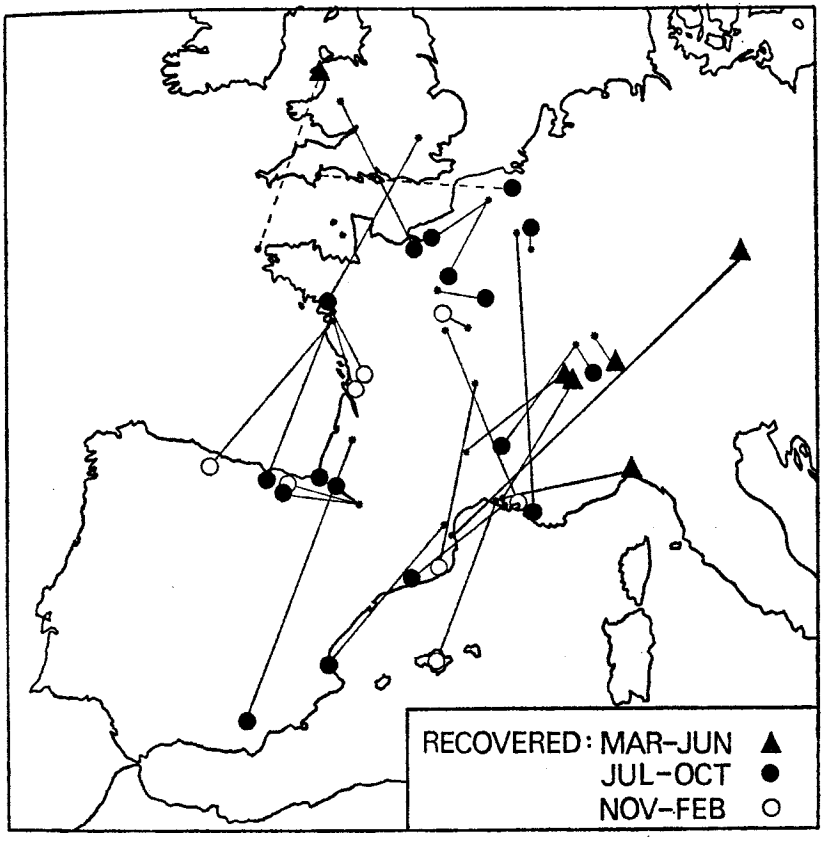

Figure 4. Recoveries showing movements over 60 km (37 miles) of French-ringed Kingfishers within 12 months of ringing (up to 1970), and all recoveries between Britain and Europe. (Solid lines denote recoveries within 12 months of ringing; dashed lines denote recoveries more than 12 months after ringing.)

debouches into the Mediterranean certainly experiences a large influx of Kingfishers in autumn (Kramer 1966). Birds from the Alps move south, and there is evidence of return movements in the spring. Some Kingfishers proceed farther, to east Spain, and there is one recovery on Majorca (Balearic Islands). From the western Pyrénées movement is westwards in the autumn to winter quarters in southwest France and northern Spain. There appears to be virtually no pattern of long-distance movements across France, although there is at least one recovery of a Czechoslovakian-ringed bird on the Atlantic coast.

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SUMMARY

The data collected to the end of 1974 by the BTO Nest Records (173 cards) and Ringing Schemes (222 recoveries), were analysed.

Kingfisher breeding habitats and nest sites are described, with details of tunnel length and height above water. The breeding season is extensive, egg-laying taking place from early March to late July. Two broods are usual, with occasionally a third. Average clutch size is 6.3 and average brood size (the number of young surviving to 18 days or more) 5.2; 62% of nests are successful, and therefore productivity from two broods per pair per year is 6.5 young.

The average annual mortality, derived from ringing recoveries, is 76%. The seasonal pattern of mortality is described, 61.5% of juveniles being recovered in August/September, and most adults in April at the onset of the breeding season. The most common recovery phrase indicating cause of death is 'found dead on road'. Two-thirds of British Kingfishers are recovered less than 9 km (5.6 miles) from the place of ringing. British movements over 64 km (40 miles), and those between Britain and the Continent, are plotted on maps, along with movements over 60 km (37 miles) of French-ringed Kingfishers.

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