Decline of the House Sparrow: a Review

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Abstract

The House Sparrow is closely associated with man and his domestic animals. The population in Britain suffered a major decline, particularly in built-up areas, when the horse was replaced by the internal combustion engine in the 1920s, before stabilising at a new lower level. The mixed fortunes of the bird since then are examined, emphasising that different factors operate on the farmland populations and those inhabiting built-up areas. The former declined by about 60% between 1979 and 1995, but then stabilised at a new lower level. The farmland decline is attributed to changes in agricultural practices. The situation with the birds in the built-up areas is much more complex with a gradual decline up to about 1990, followed by a massive decrease that has resulted in almost complete extinction in certain urban centres, whereas the numbers in suburban areas and small rural towns have shown little, if any, decrease. Some speculative ideas are put forward to account for the situation in the built-up areas.

Introduction

The recent decline of the House Sparrow (Passer domesticus) in the United Kingdom and parts of western Europe is widely recognised (Summers-Smith 1999; Crick et al. 2002), the Telegraph Magazine of 28.12.02 even marking the entry of the bird on the Red List of UK endangered species as one of the notable events of the year 2002! This paper aims to describe the present situation, recognising that there are substantial differences between the situation in farmland, urban centres and small rural towns and suburbs, and, moreover, between the UK and the neighbouring continental mainland. The decline of the House Sparrow in farmland parallels that of many other farmland species, but the situation in the built-up areas is much less clear. There is currently much interest in the decline of the species in Britain and the neighbouring countries on the continental mainland. Some speculative ideas are put forward with a view to suggesting possible areas in which further research is needed.

The Farmland Situation

Data on the situation in farmland are provided by the Common Bird Census (CBC) enquiry of the British Trust for Ornithology (BTO) that gives a Population Index based on annual surveys of 200-300 sample areas of approximately 100 ha distributed over the UK (Marchant et al. 1990). Although the CBC began in 1962, sufficient data did not become available to obtain a reliable index for the House Sparrow until 1970. The Population Index for the House Sparrow from 1970 to 1999 is plotted in fig. 1. This shows an increase up to 1979 followed by a decline of about 60%, though this had flattened out by 1995, suggesting that the farmland population has now stabilised at a new, lower level.

This decline is in line with that of many other farmland species (Fuller et al. 1995) and is attributed to changes in farming practices:

- the switch from spring to autumn sowing of cereals
- increased use of pesticides • increased use of herbicides
- switch from haymaking to silage before the grass has set seed
- reduced spillage of grain and improved storage to meet EU regulations

that reduced the availability of food, both the seeds that sustain the birds throughout the year and the invertebrates that are required by the House Sparrow for rearing its young (Summers-Smith 1980). Studies have suggested that the major impact has been a reduction in the survival rate (Siriwardena et al. 1999), specifically of first year birds (Crick et al. 2002), rather than a decrease in productivity.

Situation in the Built-up Areas

The CBC has two limitations as far as the House Sparrow is concerned:

- results are limited to farmland (and woodland) and thus do not give information on the situation 'in the built-up areas, the prime habitat for the bird
- there is a strong bias to the populous south east so that the results do not necessarily reflect the true situation over the UK.

The only trend data for House Sparrows in built-up environments come from Kensington Gardens, London; these include autumn counts that began in 1925 and have been repeated somewhat erratically since then, together with five from spring and the breeding season (Sanderson 1995, 1999, 2001). These results are plotted in fig. 2, the breeding season counts being plotted as estimates for the previous autumn by assuming a 25% winter loss (Summers-Smith 1959). Fig. 2 shows a decline that appears to have occurred in three phases. First an initial steep decline in the 1920s caused by the replacement of the horse by the internal combustion engine and the consequent loss of food to House Sparrows from spillage from nosebags and undigested seed in the droppings (Summers- Smith 1963). There is only one count available for this period, but it is likely that by the start of the 1930s the population had eventually stabilised at a new level. (This phase is shown tentatively by a dashed line.). Second, a gradual decline from 1945 to 1975 ($r = -0.78$, ns, $n = 4$). Third, a final phase of rapid decline from 1996-2001 ($r = -0.89$; $P < 0.05$; $n = 6$). The transition from the 2nd to the 3rd phase is not defined precisely, but for the sake of illustration the phases are joined by extrapolation of the lines of best-fit. Anecdotal evidence in support of the last phase is given by numerous letters to the press from the general public.

In the absence of trend counts, some information on the urban centre situation is given by sample censuses from three British cities: London (R. Bland "Analysis of London Natural History Society counts from 1925-1998", pers. comm.) Glasgow (author) and Edinburgh (Dott & Brown 2000), supplemented by counts from Dublin, Ireland (author), and Hamburg, Germany (Mitschke et al. 1999a, 1999b; Mitschke in press). These are shown in fig. 3 superimposed on the plot for Kensington Gardens taken from fig. 2. The points are plotted as breeding season densities, autumn count figures being reduced by 25% to allow for losses up to the breeding season. The sample census results clearly support the separation into the 2nd and 3d phases, particularly with the repeat censuses from all locations confirming the major decline in the 1990s.

Similar census counts from small rural towns are also plotted in fig. 3: data from Stockton-on-Tees 1959 (Summers-Smith 1963); Tranent 1986 (Da Prato 1989); Crewkerne 1976, 1996 (Parsons 1999); Guisborough 1997, 1998 (Summers-Smith 1999); Sandhurst 2000 (Sussex 2000); Sandhurst Crowthorne and Bracknell 2001 (Robinson 2002). These results show no significant change in House Sparrow numbers in this habitat over the period ($r = -0.15$, ns, $n = 9$), though it is possible that any small town decline may have been buffered by birds moving in from the increasingly unfavourable farmland habitat.

The BTO Breeding Bird Survey (BBS) provides more relevant data on the House Sparrow in built-up areas, though this study did not begin until 1994 (Noble et al. 2000). The BBS data demonstrate that the built-up habitat has the highest density of House Sparrows in Britain, holding over 60% of the population, with more than half of these occurring in suburban areas. This survey shows that over the period 1994-2000, the urban population decreased by 5.6%; while that in the suburban areas decreased by 3.3%.

The situation is more complicated than is suggested by the above generalisations. The urban centre situation is by no means simple; while there have been dramatic declines, almost to the point of extinction in central London (see RSPB 2003), Glasgow, Edinburgh, Dublin, Hamburg, and Ghent (pers. obs.), there appears to have been no comparable decline in Manchester (Prowse 2002), Berlin (Bohner et al. in press) and Paris (McCarthy 2000; C. Galinet & C. Wilkinson, in litt. 20.12.02). Moreover, data from the BTO BBS covering the period 1994-2000 suggest that while there has been an overall decline of House Sparrows in England, the species has actually increased in Scotland and Wales (Raven et al. 2002).

While the separation of the built-up habitat into large town centres and small rural towns/ outer suburbs is a convenient generalisation, the urban habitat is by no means uniform and detailed studies have shown that the decline in built-up habitats has been patchy. The patchiness of the decline in London is well demonstrated by the Summer 2002 Survey organised by the Royal Society for the Protection of Birds study (RSPB 2003). This is also shown in other studies; for example, Paston (2001), Robinson (2002) and Tully & Bland (2002) found the decline to be more severe in the 'leafy' suburbs than in the more socially-deprived areas, whereas Nicholson (in press) found that the presence of House Sparrows in suburban Oxford was positively related to the density of bushes, particularly of native species, in gardens. In the outskirts of Hilversum, in the Netherlands, van der Poel (2002) showed that the birds favoured the newer buildings (later than 1953) rather than the older ones. These differences tell us more about the habitat preference of the species, but perhaps the habitats abandoned by the birds also provide some clues on the factors influencing the decline.

Discussion

For a species to decline there must be either a reduction in breeding productivity or in survival. Survival can be determined from ringing recoveries or re-sighting of colour-ringed individuals; determination of breeding productivity is much more difficult for a multi-brooded species like the House Sparrow unless individuals are marked and their breeding activities are followed through the breeding season, though, where possible nest sites are limited, pairs tend to use the same site throughout the year, even through life.

In fact, it is over-simplistic to treat productivity and survival as independent. The adults may work harder to maintain their output at a cost to their survival. Shortage of winter food may not reduce survival, but could delay the onset of breeding, though this is not supported by analysis of the BTO Nest Record Scheme (NRS) which suggests that the beginning of breeding has advanced by 5 days in the past 25 years (Crick et al. 2002) in line with climate change. Moreover, a proportion may fail to breed or possibly rear young that are not fit enough to survive and fill the gaps in the breeding population.

The situation in farmland and urban centres appears to be quite distinct. In the former habitat a major decline began in the late 1970s, but after a decrease of about 60% the population had stabilised at this lower level by about 1995 (fig. 1). In contrast there has been a gradual decline in the urban centres that has been going on since the 1930s with little change until the late 1980s or early 1990s when the urban population went into free fall and is now close to extinction in the centres of London, Edinburgh and Glasgow (fig. 3). A gradual decline is probably also taking place in small towns and the suburbs of larger towns; like that in the centres this decline is still in progress though it has not yet become catastrophic.

There is no evidence of any significant interchange of House Sparrows between the farmland and urban populations (Summers-Smith 1956; Wernham et al. 2002) and it is almost certain that the factors for the declines are largely unrelated. Thus, while the work of the Farmland Bird Group at Oxford (Hole et al. 2002) has provided sufficient information to assess the relevance of productivity and survival for the farmland birds, it is not necessarily relevant to the urban populations.

Even the urban population itself is far from homogeneous and it is probably more realistic to separate the birds in the built-up habitat into two sub-groups: urban centres and outer suburbs/small towns (possibly even three, the latter even being further divided by separating the birds living in rural built-up areas), The key parameter defining these habitats is the 'home range', the foraging area utilised by the birds, which for adult House Sparrows is a radius of 1-2 km round the breeding colony.

The following explanations have been proposed for the urban House Sparrow decline.

- increased predation by Magpies(Pica pica),Sparrowhawks(Accipiter nisus)and domestic cats (Felis catus)
- competition for food by other urban species, Feral Pigeons (Columba livia) and gulls, particularly Lesser Black-backed Gulls (Larus fuscus)
- loss of potential breeding sites
- spillover from the farmland decline
- disease
- increased traffic

Any reason that is to have any credence must obviously be consistent with the difference between the two main urban habitats.

(i) Predation
While Magpies and Sparrowhawks have increased in urban areas over the period of interest there is no reason why they should have a differential effect in these two habitats; moreover, the Magpie is a predator of eggs and chicks in open nests and is unlikely to have had much impact on sparrows that breed in enclosed sites inaccessible to them. The domestic cat is a significant predator of House Sparrows (Churcher & Lawton 1987). A recent report by Woods et al. (in press) suggested that cats (both domestic and feral) accounted for 26 million House Sparrows in Britain 1997; this can be compared with a total population of 49 million (Crick et al. 2002). This is a significant cull rate, but it is a spot check and it is not known if the number of cats has increased over the period of interest. However, with a limited supply of prey in the urban centres a differential effect between these and small rural towns must be a definite possibility.

(ii) Competition
Town Pigeons and gulls are the main potential competitors for food. It seems unlikely, however, that either of these would give a differential effect between the two built-up habitats.

(iii) Loss of nesting opportunities
House Sparrows prefer holes for nesting. A reduction in the availability of suitable sites in modem buildings and through the rehabilitation of old buildings must have occurred. This could even have a differential effect in

rural towns and modern housing estates where thick hedges provide alternative nesting opportunities.

(iv) Spillover from Farmland
The farmland decline preceded that in the urban centres and it has been proposed that the urban decline was a consequential effect, This seems very unlikely, both because of the lack of evidence of significant interchange of birds between these habitats and, moreover, any farmland effect would have been more likely to have had an impact on small rural towns surrounded by farmland, as mentioned earlier, than in the urban centres.

(v) Disease (parasites and pathogens)
Declines of House Sparrows resulting from epidemic disease have been reported (Menegaux 1919-21; Stenhouse 1928), but these have been characterised by the presence of corpses and their limited duration as the disease organism attenuates and the host develops resistance, quite different in character from the present urban centre decline that has been going on for at least IO years. This is typified by the extreme case of the Black Death epidemic in the 14th century, which although it killed off about one third of the human population, was only acute for less than three years (1337-1340) before beginning to die out (Skip Knox 1995).

(vi) Traffic
Two effects of increased traffic have been mooted:

- increased disturbance

- increased pollution from exhaust fumes.

Both of these would be expected to have a greater impact in large urban centres than in small rural towns and suburbs, but, while increased traffic could have a depressing, effect it seems unlikely that on its own it could have been responsible for the timing of the urban centre decline. On the other hand, a significant environmental change was the introduction of unleaded petrol in the UK in 1989. This involved the replacement of the octane improver tetra-ethyl lead (TEL) by methyl tertiary-butyl ether (N4TBE). The latter is a carcinogen, though it was suggested that it would not enter the environment as it would be fully combusted in the engine. This did not, however, take into account spillage at filling stations and the possibility of incomplete combustion in engines idling when stationary at traffic lights.

There is some circumstantial evidence that suggest that this change might be implicated in the House Sparrow decline:

- Peter Joseph of the University of Pennsylvania investigating an increase in asthma in children and domestic cats in Philadelphia attributed this to toxic vapours (methyl nitrite, compounds with hydroperoxy radicals) that he found in the exhausts of engines running on unleaded petrol (Joseph 1999). These are unstable compounds, particularly when exposed to ultra violet radiation, and it seems unlikely that they could cause the death of higher organisms like sparrows, but it is possible that they could reduce the populations of the invertebrates on which the sparrows depend to rear their young.

- Simon Bower (1999) investigating the breeding biology of the House Sparrow in Hamburg in 1999 found that none of the 1st (April) broods were successful; July broods that were successful were raised entirely on animal food for the first few days. Bower attributed the decline in House Sparrows to a lack of insects, particularly at the beginning of the breeding period.

Further support to the idea that a shortage of invertebrate food could be a factor is given by a preliminary analysis of an ongoing study in Leicester (Vincent Peach & Fowler 2002). According to their breeding data for 2002, there was a complete failure of 14 broods (46%) in suburban nests, with all but one of these occurring in mid to late season clutches (after the end of May). In the majority of cases the nestlings died after only a few days, suggesting that starvation, possibly resulting from lack of invertebrate food, was the cause.

Van der Poel (2002) has also expressed the opinion that the decline in urban centres in the Netherlands was the result of the absence of insects. Unfortunately, no relevant data on invertebrate populations in urban habitats are available, and there is no consensus as to a possible cause, though garden pesticides could be a possible factor in suburbia

Studies by Siriwardena et al. (1999) and Crick et al. (2002) have suggested that a decrease in survival was the reason for the House Sparrow decline. In, contrast a lack of invertebrates would cause a decrease in productivity. There need not, however, necessarily be any conflict between these views: the former studies were based respectively on the national data-sets of the BTO and a specific farmland investigation and thus, as already mentioned, may not be relevant to the urban situation.

Comparative data on the time between feeding visits by the adults to the nest could provide some guidance on the availability of suitable food.

This still leaves open the question of why the decline should be limited to the House Sparrow and why other urban species should not be similarly affected. The other significant urban species, the Feral Pigeon, rears its young entirely on a vegetable diet and would thus not be affected by a shortage of invertebrates. Other small passerines do not form a significant part of the urban avian biomass so that any decline would be less easily noted; moreover, they are extremely mobile, unlike the sedentary House Sparrow, and thus capable of quickly filling in gaps, even if the birds moving in are still unsuccessful.

An Hypothesis

It is suggested that the following factors have been responsible for the urban centre decline, but with a smaller effect in small rural towns and suburbs.

- increased predation by domestic cats
- a loss in nesting opportunities
- pollution from vehicles running on unleaded petrol. (A possible explanation for the absence of a significant decline in Paris could be that the price of diesel fuel in France is approximately half that of petrol leading to a proportionately higher usage of diesel-engined vehicles.)
- increased use of pesticides in parks and gardens.

The House Sparrow is a social animal that nests in loose colonies and depends on social stimulation for its breeding success. Reduction of colony size below some critical value may impair breeding behaviour to the extent that success declines, resulting in the disappearance of the colony as a breeding unit. This is known as the "Allee Effect" (Allee 1938), one of the best known examples probably being the final demise of the Passenger Pigeon (Ecopistes migratorius) following reduction in numbers because of human exploitation (Halliday 1980). Such an effect is shown schematically in fig. 4. The way gaps in the breeding population were quickly filled prior to the decline (Summers- Smith 1963), provides circumstantial evidence for the presence of 'floaters', viz. birds that

could not find a gap in the existing social communities. Reduced breeding output because of breeding impairment and loss of colonies due to an Allee Effect would reduce the numbers, and possibly the quality, of such floaters available to fill gaps in other colonies, increasing the likelihood of decline. This effect could explain the difference between the urban centres and the small rural towns, the decrease in the latter, where it has occurred, not having reduced the colonies to the critical size. Some support is given for this idea by a study of House Sparrows in London currently being carried out by Helen Baker (pers. comm.). Analysis of the preliminary data suggests that the decline she has recorded is not merely a function of reduction in colony size, but rather of increased dispersion of the colonies.

These ideas are not presented as "the answers" to the problem, but in the hope of stimulating further research to test them, and other, possibilities to provide insights into the erratic nature of House Sparrow declines in different built-up areas.

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Captions for figures,

Fig. 1. Population Index for the House Sparrow.
(Based on BTO Common Bird Census.)

Fig. 2. Autumn numbers of House Sparrows in Kensington Gardens, London. Based autumn counts and breeding population estimates, the latter plotted as the number in the previous autumn assuming a winter loss of 25%. (1945-1975: r = -0.78, ns, n = 4),1996-2001: r = -0.89, P < 0.05, n = 6).

Fig. 3. Breeding season density of House Sparrows in built-up areas, based on sample censuses:
Red - Kensington Gardens (autumn counts have been reduced by 25% to allow for losses up to the breeding season)
Black - Large town centres (London, excluding the Kensington Gardens data, Edinburgh, Glasgow, Dublin, Hamburg)
Green - Small rural towns.

Fig. 4. Schematic representation of the "Allee Effect".

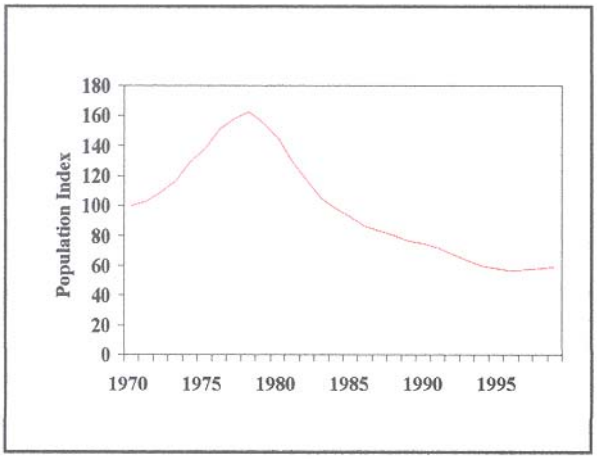

Fig 1

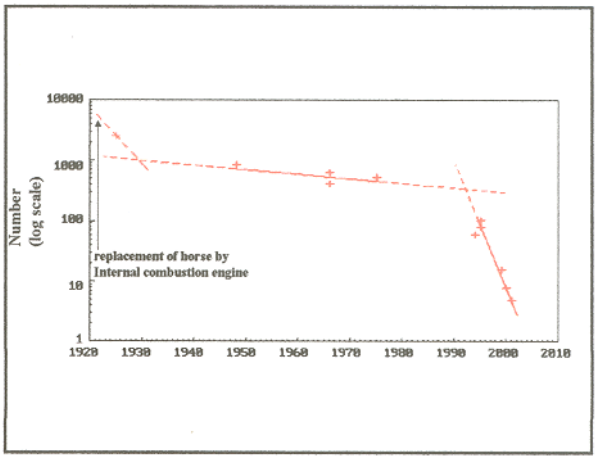

Fig 2

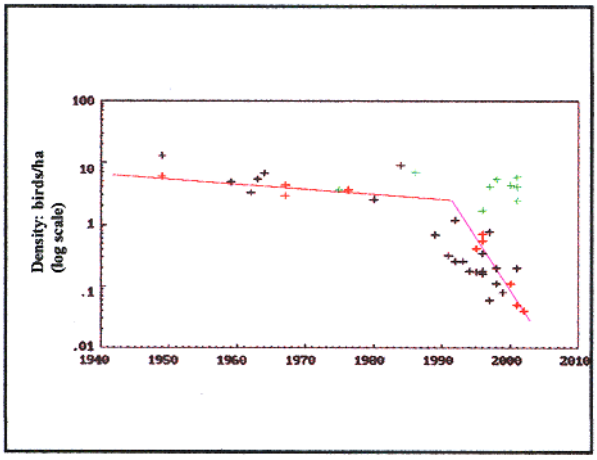

Fig 3

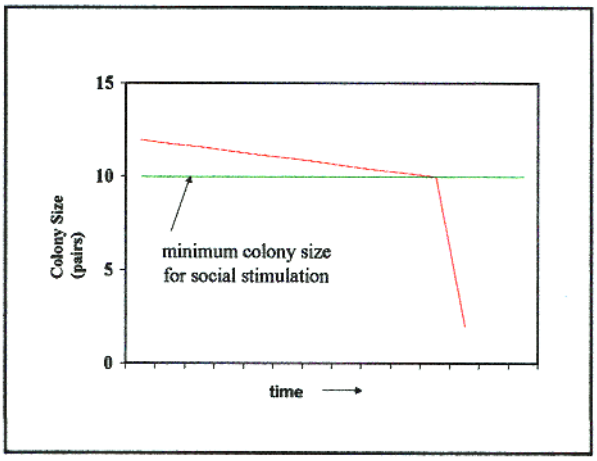

Fig 4