Investigating the role of socioeconomic status in determining urban habitat quality for the house sparrow, *Passer domesticus*

SUBMITTED BY LORNA MARGARET SHAW TO THE UNIVERSITY OF EXETER AS A THESIS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN BIOLOGY; 29TH SEPTEMBER 2009.

I certify that all material in this thesis which is not my own work has been identified and that no material has previously been submitted and approved for the award of a degree by this or any other university.

……

ABSTRACT

Urban areas are increasingly recognised as an important resource for wildlife, as studies have shown that gardens, parks and brownfield sites can contain high insect and plant diversity. Urban centres can also provide resources for species of conservation concern, and it is therefore important to monitor urban habitat quality and ensure the maintenance of urban biodiversity. However urban habitats are often difficult to monitor effectively due to access and sight restrictions in built up areas. This thesis investigates urban habitat quality in relation to an urban specialist species, the House Sparrow *Passer domesticus*. After considering the importance of urban habitats for biodiversity in general, I review the current status and distribution of the house sparrow in urban areas, with particular reference to the possibility that human socioeconomic status has influenced the decline of the species in some urban areas. I then consider which features of urban houses and gardens may provide a potential explanation for inter-city variation in habitat quality for urban birds. I present evidence that the age of houses; the prevalence of roof repairs; and the presence of extensive paved areas such as driveways are linked to areas with low levels of socioeconomic deprivation. I then use nationwide data to establish that house sparrows in English cities are more likely to occur in areas that are relatively deprived. Furthermore, analysis of land use data confirms that house sparrow occurrence decreases with increasing levels of building and paving, and increases with the area of green space available. However, house sparrow occurrence also appears to decrease with increasing garden area, a surprising finding given that gardens are important foraging habitats for urban birds. By radio tracking house sparrows in urban Bristol, I show that gardens are heavily utilised by house sparrows, but that those with a high proportion of paving are avoided. It appears that changes to areas with low levels of socioeconomic deprivation, notably an increase in paved areas, may have contributed to the urban decline of house sparrows in less deprived parts of English urban areas. These findings are discussed in relation to future urban planning requirements, and the need to mitigate for the detrimental effects of urban development on species of conservation concern. The contribution of large, nationwide datasets to the monitoring of urban habitats, and the implications of these findings for other urban species, including humans, are also highlighted.

ACKNOWLEDGEMENTS

This PhD was funded by an NERC “blue skies” CASE studentship, in partnership with the British Trust for Ornithology (BTO). The study was supervised by Matthew Evans (University of Exeter) and Dan Chamberlain (BTO), and I thank them for the essential advice and assistance given to me during my research. I would like particularly to thank Dan and the many other staff at the BTO for their support and encouragement on the many visits I paid to the BTO headquarters at Thetford – your suggestions were invaluable. In particular I thank Mike Toms for providing me with BTO GardenBirdWatch data on house sparrows; Steve Freeman and Simon Gillings for statistical advice. Thank you also to the BTO GardenBirdWatch volunteers, who enabled the collection of the nationwide data on sparrows, without which this PhD would not have been possible.

Data from a number of sources was used during this PhD. As well as the BTO GardenBirdWatch, National Statistics data on deprivation and land use was used from www.statistics.gov.uk. Ordinance survey maps were obtained from DIGIMAP (http://edina.ac.uk/digimap).

I would also like to thank the staff at the Centre for Ecology and Conservation at Exeter University, many of whom have given up their time to help me at some stage or other. In particular I would like to thank Andy MacGowan for taking time out to travel to my field sites and help me catch and radio tag birds, and for providing feedback on my work. Thanks also are due to David Carslake for spending a substantial amount of time helping me get to grips with GLMMs and R software. I am also grateful to Thais Martins for help with data sorting; and to members of the Exeter and Plymouth Bird Biology group for advice and feedback on my work, in addition to the many other people who have answered my queries from time to time.

I would like to acknowledge in particular the many people who helped me to carry out the local scale work, in particular John Tully and Richard Bland, whose detailed studies of bird populations in Bristol first provided the inspiration for this PhD. Thanks also go to the Bristol residents who took part in the questionnaire surveys and radio-tracking study, in particular to Rodney Holbrook, Nicola Ramsden, Mitch Crossingham, Susan

Slatter, Mr and Mrs Brookman, Pru and Brian Comben, and Mrs Wilmer for allowing me to catch birds in their gardens. Radio tags were provided by Biotrack, thanks to Brian Cresswell and staff for advice and assistance. Thank you also to Bristol City Council, Horfield housing association and the Friends of Troopers Hill, for assistance in distributing surveys.

I would also like to thank Denis Summers-Smith, who has been researching sparrows for over 50 years and whose advice, information and support have been invaluable. I hope that the results of this study will be a valuable addition to the growing literature on the species, and help further the study of this familiar yet often overlooked bird. In addition to Denis, there are many other house sparrow researchers who have provided helpful ideas and advice, notably the members of the house sparrow discussion forum.

Finally, thank you to my family and friends, especially those in the office who have been in close proximity on days when I was losing the battle to get sense out of R. All those who have aided the de-stressing process by sharing walks, chocolate breaks and the occasional pint are greatly appreciated! Special thanks go to James Goodey, for not only managing to be pleased by the news that my PhD would take me 400 miles away for a few years, but for putting up with all the subsequent PhD-related stress. You deserve a medal!

CONTENTS

Appendices:

LIST OF TABLES

Table 3: Summary of Generalised Linear Mixed effects Models for each of four major land use types in English LSOAs in relation to house sparrow occurrence. In all cases the presence\absence of house sparrows was treated as a binomial response variable, and GBW site was a nested factor. Model parameters shown are for the minimal adequate model for each land use type.

Table A1: The distribution of each land use type on the first three principal components obtained by running PCA with Varimax rotation and Kaiser Normalisation. A high figure denotes that the land use type contributed a relatively large proportion of the variation on that principal component. Also shown are the initial eigenvalues for the first three principal components, and the cumulative variance explained by each.

CHAPTER 6:

Table 1: Details of the 19 radio tagged birds. Birds highlighted in bold were detected on >15 occasions after release.

Table 2: Mean area and perimeter values for house sparrow home range kernel density estimates.

Table 3: T-statistics and P-values comparing habitat selection by house sparrows relative to the availability of five habitat types, as determined by compositional habitat analysis (Aebischer *et al;* 1993). Preference rankings for each habitat type are shown, with 0 = least preferred. The reference habitat type was paving.

Appendix 6A: Home range areas and kernel densities for house sparrows in urban Bristol.

APPENDICES:

Table A1: Summary of Generalised Linear Mixed Effects model linking house sparrow occurrence to the Welsh Index of Multiple Deprivation for 2005. Parameters from the minimal adequate model are shown.

Table A2: Measures of prediction success for London GBW data, modified from Petit *et al;* 2003), where a = true positive, b = false positive, c = false negative, and d = true negative. The threshold for occurrence for house sparrows at GBW sites was set at 0.5, as in the original model.

Table A3: Summary of models linking the principal components of urban land use types to house sparrow occurrence (GLMMs, Φ) and deprivation (linear models, †). Starred terms indicate significant interaction effects.

LIST OF FIGURES

CHAPTER 3:

CHAPTER 4:

(dashed line), 2000 (solid line) and 2005 (dotted line), according to the deprivation score (IMD), where 0 = least deprived All values shown are for an average LSOA size of 700 000m^2. Note that the scale of a) differs from b), c) and d).

Figure 2: The probability of seeing house sparrows at GBW sites (y-axis) by year (x-axis), showing seasonal variations during the years of the GBW survey, where spring = dashed line, summer = dotted line, autumn = solid line and winter = grey line. Variations in the level of deprivation (IMD) at GBW sites are shown, from 20 (less deprived sites) to 80 (most deprived sites). a) = IMD of 20; b) = IMD of 40; c) = IMD of 60; d) = IMD of 80.

CHAPTER 5:

Figure 1: The probability of house sparrow occurrence at GBW sites derived from GLMM parameter estimates for the main urban land use types: a) paving, b) buildings, c) gardens and d) green space. Estimates shown are for average sized LSOAs, and three years are shown, 1995 (dashed line), 2000 (solid line) and 2005 (dotted line). Parameter estimates shown are for spring.

CHAPTER 6:

Figure 1: Kernel density contours for the home ranges of four of the house sparrows tagged in urban Bristol in 2007 and 2008. The tagging location is denoted by a red star. Note that the home ranges of the four birds encompassed housing in all directions except to the North-East of the tagging site – this area consisted solely of modern housing. The core home range of two of the individuals (in blue and yellow) centred on a house that had been unoccupied for eight years, and was consequently in poor condition.

Figure 2: Kernel density area estimates for randomly selected subsamples of the radio tracking data, using varied sample sizes. Black = 25% contours; Red = 50%; Blue = 75%; Green = 95%.

Figure 3: Post war housing in Bristol (top), and modern housing (below). Modern housing in Bristol is built at up to twice the density of previous developments, leaving little room for the planting of mature trees and shrubs. Modern housing also has flatter tiles and more airtight roof spaces than older housing, limiting nesting opportunities.