

## Supplementary Material

Surviving in the city: annual and seasonal survival variation in Mediterranean house sparrows *Passer domesticus* DOI: 10.25225/jvb.26024

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**Table S1.** Summary of the goodness-of-fit (GOF) of the initial annual and seasonal model assessment. GOF testing is the procedure that checks for model assumptions fulfillment: 1) test of transients (Test 3.SR): newly encountered individuals have the same chance to be later reobserved as recaptured (previously encountered) individuals; 2) test of trap-dependence (Test 2.CT): missed individuals have the same chance to be recaptured at the next occasion as currently captured individuals; and 3) the overall test. For the annual survival, only the overall CJS test was carried out due to data restrictions.

Annual Survival		Adult Males	Adult females	Juveniles
Overall_CJS	X <sup>2</sup> (df)	1.130 (4)	0.589 (2)	0.359 (2)
	P	0.889	0.745	0.836
Seasonal Survival				
TEST 2.CT	X <sup>2</sup> (df)	10.520 (8)	13.843 (10)	15.157 (11)
	P	0.230	0.180	0.175
TEST 3.SR	X <sup>2</sup> (df)	6.499 (7)	5.904 (5)	3.911 (5)
	P	0.483	0.316	0.562
Overall_CJS	X <sup>2</sup> (df)	21.229 (22)	21.934 (29)	24.232 (29)
	P	0.507	0.844	0.717

**Table S2.** Summary table compiling house sparrow survival data from European populations. Significant differences in annual survival between sexes are indicated with an asterisk. Combined in population means that data from local and National Schemes were used.

Years	Period	Juvenile survival	Adult survival	Country (Region/city)	Habitat	Population	Reference
Pre-1990							
-	Stability	0.3	0.58	Great Britain	-	Combined	Summers-Smith (1956)
-	Stability	0.19	-	Great Britain	-	Local	Summers-Smith (1963)
-	Stability	0.25	0.40	Western Germany	-	Local	Deckert (1969)
-	Stability	0.57	0.65	France	Rural	Local	Gramet (1973)
-	Stability	-	0.63	Great Britain (England)	Non-urban	Combined	Dyer et al. (1977)
1962-1975	Stability	0.55	0.59	Great Britain	-	Country	Siriwardena et al. (1999)
1965-1975	Stability	0.53	0.58	Great Britain	-	Country	Freeman & Crick (2002)
1966-1978	Stability	-	0.55	Great Britain	-	Country	Dobson (1990)
1966-1978	Stability	-	♂ 0.52/♀ 0.61*	Great Britain	-	Country	Dobson (1987)
1977-1981	Stability	0.41	0.66	The Netherlands (Adriaen)	Suburban	Local	Heij & Moeliker (1990)
1977-1981	Stability	0.32	0.43	The Netherlands (Strijensas)	Rural	Local	Heij & Moeliker (1990)
1976-1989	Stability	0.66	0.70	The Netherlands	-	Country	Klok et al. (2006)
1976-1994	Decline	0.45	0.52	Great Britain	-	Country	Siriwardena et al. (1999)
1980-1983	Decline	0.30	0.61	Great Britain	-	Country	Freeman & Crick (2002)
1980-1986 (mild years)	-	-	0.4-0.5	Spain (Tiana)	Rural	Local	Senar & Copete (1995)
1984-1985 (freezing year)	-	-	0.17	Spain (Tiana)	Rural	Local	Senar & Copete (1995)
1990-2000							
1993-1994	-	0.22	-	Norway (Helgeland archipelago)	-	Local	Ringsby et al. (1998)
1993-1995	Stability	0.21	0.60	Norway	-	Local	Saether et al. (1999)
1993-1997	-	0.24	0.61	Norway (Helgeland archipelago)	-	Local	Ringsby et al. (1999)
1993-1998	-	-	0.61 (Residents) 0.51 (Dispersers)	Norway (Helgeland archipelago)	-	Local	Altwegg et al. (2000)
1993-1999	Decline	0.31	0.52	Norway (Ytre Kvarøy)	Rural	Local	Ringsby et al. (2006)
1998-2000	Decline	0.34	0.47	Great Britain (Oxfordshire)	-	Local	Hole (2002)
1990-2003	Decline	0.62	0.66	The Netherlands	-	Country	Klok et al. (2006)
Post 2000							
1998-2012	-	-	♂ 0.56/♀ 0.50*	Norway (Helgeland archipelago)	-	Local	Saatoglu et al. (2025)
2003-2019	Decline	-	♂ 0.46/♀ 0.43	United Kingdom	-	Country	Massimino et al. (2023)
2000-2022	Decline	-	0.51	Spain (Catalonia)	-	Regional	Institut Català d'Ornitologia ICO (2025)
2011-2019	-	-	0.40-0.58 (0.49)	The Netherlands	Urban-Rural gradient	Country	Brouwer et al. (2024)
2017-2021	-	0.28	♂ 0.48/♀ 0.35*	Spain (Alcoy)	Urban	Local	This study

**Table S3.** Model selection results for Generalized Linear Mixed Models (GLMMs) fitted to evaluate variation in house sparrow survival estimates of adult and first-year birds over time. The response variable was average survival across the study period, and predictor variables included time (midpoint of the study period) and study scale (local *vs.* country). Models were weighted by the number of years used to estimate survival in each study. Models are ranked by AICc, and  $\Delta$ AICc values are provided relative to the best-fitting model. \* $P < 0.05$ , \*\* $P < 0.01$ , \*\*\* $P < 0.001$ .

Intercept	SE	Time	SE	Scale	SE	AICc	Delta AICc
Adults							
26.864	1.920 ***	-0.013	0.001 ***	-0.517	0.046 ***	-698.231	0.000
21.515	2.357 ***	-0.011	0.001 ***			-602.600	95.631
0.316	0.128 *			0.357	0.060 ***	-565.803	132.428
0.180	0.104					-536.152	162.079
First-year							
32.907	4.502 ***	-0.016	0.002 ***	1.105	0.077 ***	-336.855	0.000
23.941	10.263 *	-0.012	0.005 *			-215.281	121.575
0.133	0.139			-1.008	0.086 ***	-298.939	37.916
-0.416	0.270					-208.960	127.896

Country is the reference level in the scale variable.

## Literature

- Altwegg R., Ringsby T.H. & Sæther B. 2000: Phenotypic correlates and consequences of dispersal in a metapopulation of house sparrows *Passer domesticus*. *J. Anim. Ecol.* 69: 762–770.
- Brouwer L., De Vries E.H.J., Sierdsema H. & Van Der Jeugd H.P. 2024: A country-wide examination of effects of urbanization on common birds. *Anim. Conserv.* 27: 698–709.
- Deckert G. 1969: Zur Ethologie und Ökologie des Haussperlings (*Passer domesticus* (L.)). *Beitr. Vogelkd.* 15: 1–84.
- Dobson A.P. 1987: A comparison of seasonal and annual mortality for both sexes of fifteen species of common British birds. *Ornis Scand.* 18: 122–128.
- Dobson A.P. 1990: Survival rates and their relationship to life-history traits in some common British birds. *Curr. Ornithol.* 7: 115–146.
- Dyer M.L., Pinowski J. & Pinowska B. 1977: Population dynamics. In: Pinowski J. & Kendeigh S.C. (eds.), *Granivorous birds in ecosystems: their evolution, populations, energetics, adaptations, impact and control*. Cambridge University Press, New York, USA: 53–107.
- Freeman S.N. & Crick H.Q.P. 2002: Population dynamics of house sparrows *Passer domesticus* breeding in Britain: an integrated analysis. In: Crick H.Q.P., Robinson R.A., Appleton G.F. et al. (eds.), *Population dynamics of house sparrows *Passer domesticus* breeding in Britain: an integrated analysis*. BTO Research Report 290, DEFRA, Bristol, UK: 193–212.
- Gramet P. 1973: Structure et dynamique d'une population de Moineaux domestiques, *Passer domesticus* (L.). Résultats préliminaires. In: Kendeigh S.C. & Pinowski J. (eds.), *Productivity, population dynamics and systematics of granivorous birds*. PWN, Polish Scientific Publishers, Warsaw, Poland: 181–194.
- Heij C.J. & Moeliker C.W. 1990: Population dynamics of Dutch house sparrows in urban, suburban and rural habitats. In: Pinowski J. & Summers-Smith J.D. (eds.), *Granivorous birds in the agricultural landscape*. PWN, Polish Scientific Publishers, Warsaw, Poland: 59–85.
- Hole D.G. 2002: Adult and first-year survival in the house sparrow *Passer domesticus*. In: Crick H.Q.P., Robinson R.A., Appleton G.F. et al. (eds.), *Investigation into the causes of the decline of starlings and house sparrows in Great Britain*. DEFRA-BTO BTO Research Report No. 290, Bristol, UK: 156–160.
- Institut Català d'Ornitologia ICO 2025: Pardal comú (*Passer domesticus*). Servidor d'Informació Ornitològica de Catalunya. <https://www.sioc.cat/fitxa/Passer+domesticus>
- Klok C., Holtkamp R., Van Apeldoorn R. et al. 2006: Analysing population numbers of the house sparrow in the Netherlands with a matrix model and suggestions for conservation measures. *Acta Biotheor.* 54: 161–178.
- Massimino D., Woodward I.D., Hammond M.J. et al. 2023: BirdTrends 2022: trends in numbers, breeding success and survival for UK breeding birds. BTO Research Report 753, Thetford, UK.
- Ringsby T.H., Sæther B.-E., Altwegg R. & Solberg E.J. 1999: Temporal and spatial variation in survival rates of a house sparrow, *Passer domesticus*, metapopulation. *Oikos* 85: 419–425.
- Ringsby T.H., Sæther B.-E., Jensen H. & Engen S. 2006: Demographic characteristics of extinction in a small, insular population of house sparrows in Northern Norway. *Conserv. Biol.* 20: 1761–1767.

- Ringsby T.H., Sæther B.-E. & Solberg E.J. 1998: Factors affecting juvenile survival in house sparrow *Passer domesticus*. *J. Avian Biol.* 29: 241–247.
- Saatoglu D., Niskanen A.K., Froy H. et al. 2025: Metapopulation-level analyses reveal positive fitness consequences of immigration in a small bird. *J. Anim. Ecol.* 94: 1180–1192.
- Sæther B., Ringsby T.H., Bakke Ø. & Solberg E.J. 1999: Spatial and temporal variation in demography of a house sparrow metapopulation. *J. Anim. Ecol.* 68: 628–637.
- Senar J.C. & Copete J.L. 1995: Mediterranean house sparrows (*Passer domesticus*) are not used to freezing temperatures: an analysis of survival rates. *J. Appl. Stat.* 22: 1069–1074.
- Siriwardena G.M., Baillie S.R. & Wilson J.D. 1999: Temporal variation in the annual survival rates of six granivorous birds with contrasting population trends. *Ibis* 141: 621–636.
- Summers-Smith J.D. 1956: Mortality of the house sparrow. *Bird Study* 3: 265–270.
- Summers-Smith J.D. 1963: The house sparrow. *Collins, London, UK*.

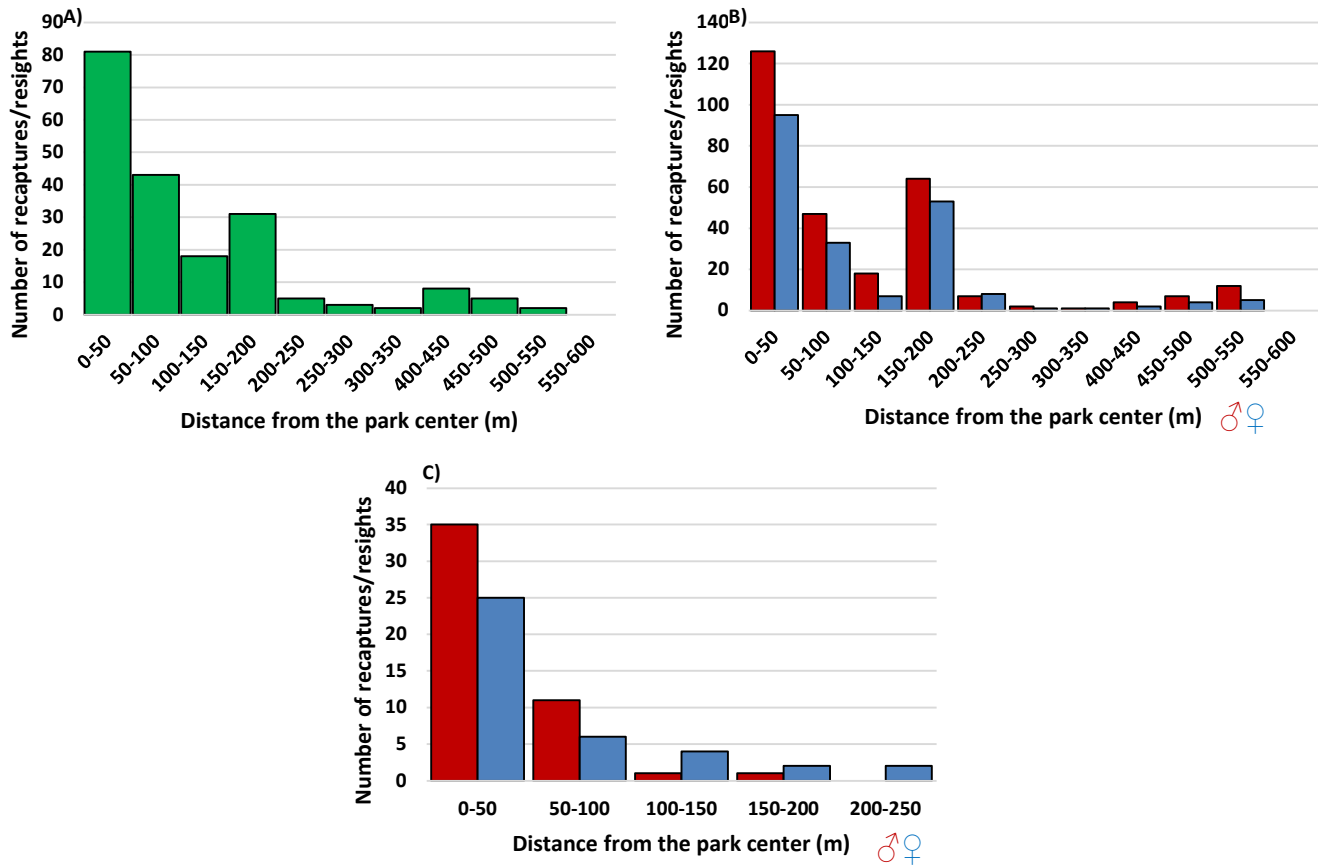


Fig. S1. Recapture and resighting distances from the central point of the park for individuals of different EURING ages: A) age three (green), B) age four, and C) age two. Males are shown in red and females in blue. To avoid temporal autocorrelation, only recaptures > 3 months after ringing were included (n = 785).

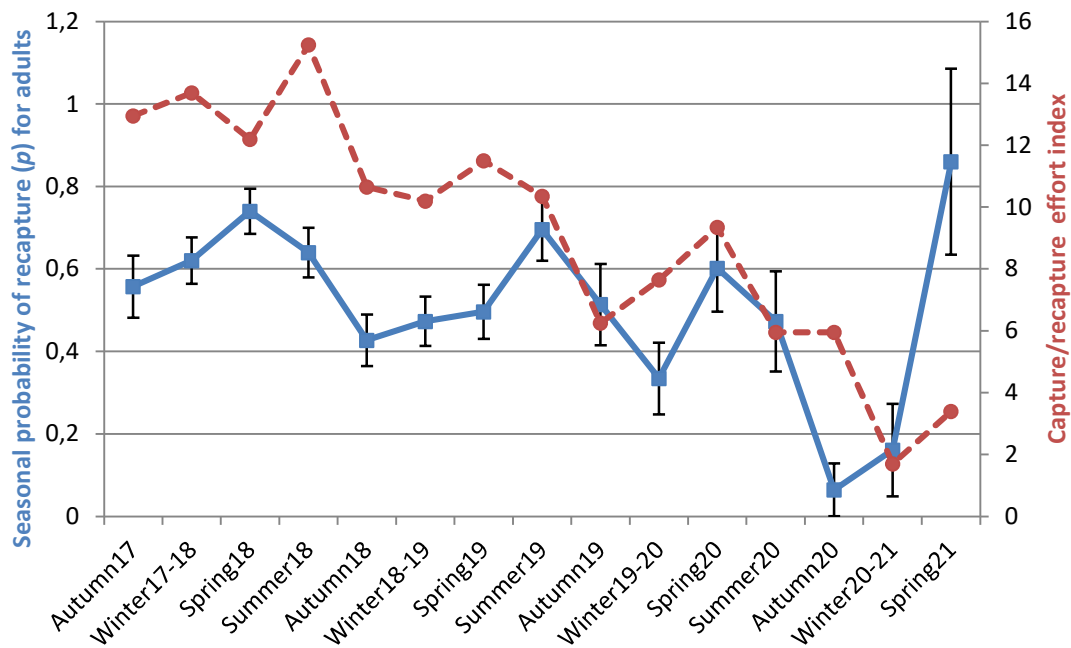


Fig. S2. Seasonal probability of recapture of adult house sparrow calculated through model averaging using the four best models of Table 2 (squares and solid line) and capture/recapture effort index (circles and dashed line).