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Long-Term Population Trends of House Sparrow and Eurasian Tree Sparrow in Spain

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Simple Summary: Urban areas are constantly increasing, as well as human activities related to them. This can lead to an effect in bird populations due to the alterations caused in nature. According to the latest national censuses in Spain, House Sparrow and Eurasian Tree Sparrow populations are decreasing. In this study, we used ringing station data from Spain to assess the tendency of both populations over a two-decade period of time. We also tried to determine the relation of these two populations and their breeding success with the habitat composition. The data analysis confirmed the decreasing trend in both species. However, Eurasian Tree Sparrow showed signs of increasing presence in urban areas, contrary to our predictions. Furthermore, the productivity of both populations remained stable over the study years.

Abstract: Urban areas are constantly increasing, which can cause an effect in bird populations since human activities lead to nature alterations. Populations of House Sparrow (*Passer domesticus*) and Eurasian Tree Sparrow (*Passer montanus*) have been decreasing in Spain according to the latest national censuses in Spain. In this study, we tried to assess the population trend over more than two decades using ringing data from Spanish constant effort sites, as well as to determine the population and breeding success proxy in relation to habitat composition at landscape level. We analysed the data and confirmed the decreasing trend in the two species. However, Eurasian Tree Sparrow showed signs of increasing presence in urban areas. Furthermore, the productivity remained stable over sampling sites and years, meaning that the causes of the decreasing populations are affecting both adult and juvenile individuals.

Keywords: habitat composition; productivity; urbanization; constant effort sites

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1. Introduction

The increase in urbanized areas impacts on biodiversity by reducing available natural habitat or fragmenting it [1,2]. Urban environments differ from natural ones in several ways, allowing some species to exploit this new habitat. First, the microclimate that big cities generate is advantageous for many species, usually the generalist ones, due to the heat island effect [3]. This not only alters the phenology of different species but also their ability to survive hard winters, increasing its fitness [4]. Urban areas also provide great amounts of food for some species, up to the point that there is usually a constant supply, due to feeding on organic waste or supplementary human feeding that occurs in urban areas [5,6]. Nevertheless, it usually is low-quality food, which may result in a diet deficiency and even differences in cell composition between rural and urban populations [7,8]. Again, generalist species are the ones who would be able to take advantage from this since they are not so demanding in their ecological niche [9]. In addition, there are low levels of predation since urban areas generally lack natural predators. This implies that there are more weak competitors in urban than in rural areas, where stronger competitors are dominant [10]. Nonetheless, feral and free-ranging cats are highly present in urban and suburban areas, which can cause individual losses or sub-lethal effects such as behavioural changes that can lead to a reproductive decrease or less food intake [11,12]. Pollution is another factor to take into consideration: society is constantly releasing chemicals which damage water, atmosphere, and ground [13]. Moreover, urban areas are more populated, resulting in more pollution than in rural ones [14]. Birds in cities are often in contact with humans. The disturbance created by people to these animals changes considering the species (bigger species display stronger alert behaviour at longer distances than smaller species) but it usually causes a decrease in foraging time, reproduction and parental care [15].

Among all urban bird species that share habitat with humans, sparrows are a representative group due to their large distribution around the planet and vast number of species. They are deeply connected to human structures as well as to their activities [16].

House Sparrow (*Passer domesticus*) is considered a sedentary species, especially in the Mediterranean area [17]. It is a well-adapted species to urban and suburban areas and it has a great ability to respond to stress in these sites [18]. It is not very selective in terms of habitat and diet. House Sparrow has been associated with human activities such as agriculture since long before ancient times [19]. It adapted to take advantage of artificial habitats such as farmlands and cities and it tends to disappear when humans are not present [20]. Since they depend on human activities, they are usually found in human inhabited areas. This species can be typically found in barns, vegetated patches, and residential areas, especially where gardens are present [21]. Such places provide them with cavities to nest (in buildings), as well as enough food provisioning to feed their nestlings (insects in parks) [22]. The House Sparrow used to be really abundant, but it has decreased markedly in recent decades [16–23]. This phenomenon has been reported not only in the countryside but also in urban environments [24–26]. The population of House Sparrow in Spain has had a 18% decrease in the last 25 years according to national censuses, even though the distribution range over the country has remained almost the same [27].

Eurasian Tree Sparrow (*Passer montanus;* hereafter Tree Sparrow in short), on the contrary, is thought to be related to wetland habitats [28,29]. It is regarded as a more natural species, not so-well adapted to cities as the House Sparrow [30], preferring parks or suburban areas when in cities, distancing from places such as main roads or commercial centres [31]. Tree Sparrow has undergone changes in population in European cities since the 20th century, when it started to colonize urban areas [32]. It has been expanding across Europe, but there is evidence that some countries have had declining trends in the last few years [33]. In Spain, decreasing numbers (−13.52%) have also been reported for this species for the last two decades [34,35]. There is no evidence of negative interactions between the two species. Moreover, House Sparrow tends to disappear from locations where Tree Sparrow cannot be found [36], and some authors point out that Tree Sparrow benefits from the House Sparrow absence [33].

The cause for the descending tendencies in both sparrow species is not clear yet. There may be not only one but several reasons, such as the loss of favourable breeding sites by new and improved construction techniques and materials, or the present management model of urban parks [21,37]. It all may affect to the productivity of the species or to their survival. Productivity is usually defined as the number of offspring a population produces each season. Productivity numbers may change depending on different factors which can affect both adult and juvenile numbers. For instance, the direction a nest faces or its height could determine the rearing success of the chicks [38,39]. In the same way, the amount of available food for nestlings would affect their chances of survival [40]. Therefore, productivity can be used as a proxy of population composition changes.

Constant effort ringing stations (CES) provide a useful approach of ringing data. The conditions must remain stable along the years, during the same breeding periods and temporal scales [41–43]. In this way, it is possible to compare population tendencies at different locations undergoing different selective pressures [44,45]. Ringing data could clarify the reason for the decline, since it allows us to identify the age of the captured birds and, thus, we would be able to estimate a productivity index for each species over a long period of time.

The aim of the present study is to determine whether there is a generalized population decrease in the ringing data of both the House Sparrow and Tree Sparrow in Spain that would reflect a global trend not influenced by local conditions, or if population declines are more restricted phenomena caused by regional or local factors such as a decrease in productivity in some geographic areas or by the difference in habitat structure. To attain that goal, we used ringing and productivity data from different constant effort ringing stations (CES). We studied (i) population trends across Spain for 27 different locations over a 25-year period and (ii) the productivity index in those locations in the same time period.

As stated above, in Spain, both species are decreasing their number, so we predict that there will be a decline in the number of captured birds over the 25-year period under study [27,34,35]. We also expect that House Sparrow will be more frequent in urban areas since they are well adapted to cities and human activities, whilst Tree Sparrow, as it is considered a non-urban species, will be associated with more natural areas. In addition, since there seems to be an overall reduction in the population of sparrows, we predict that productivity will be affected, so we will find decreasing productivity values.

2. Materials and Methods

2.1. Sparrow Data

We recorded data from a network of 27 constant effort ringing stations (Figure 1, Table 1) during the breeding season with regular trapping intervals following standardized CES protocols (no bird calls, 19 mm mesh size, sampling effort five hours after sunrise) [41–43]. The number and locations of the mist nets, as well as their technical characteristics, remained constant across the years and within localities. Accordingly, this sampling protocol allowed us to obtain standardized data that was useful in estimating breeding population trends and allows the identification of changes in juvenile and adult proportions, thus permitting estimates of variation in productivity over years and long-term trend assessment. The data analysed were provided by two different CES programs: PASER (SEO/BirdLife) and EMAN (Aranzadi) [42,43]. Both programs operate during the breeding period (April–July) with 10 sampling days in periods no longer than 10 days apart.

Table 1. Sampling locations with their respective coordinates, urbanization index (PC1 component after PCA plotting of vegetation, buildings, pavement, and water around each CES site; see below. Positive scores indicate natural areas and negative scores indicate urban areas) and active period of time in order of urbanization index.

Station Name	Town	Latitude	Longitude	Urbanization Index	Mist Net Pool Length (m)	Data Range
Parque del Alamillo	Sevilla	37°23′00	−5°57′00	4.1964	84	2001–2009
Real Jardín Botánico UCM	Madrid	40°26′00	−3°43′00	3.5131	42	2011–2021
La Murtera	Oda	39°58′00	−1°50′00	3.4190	43	1999–2009
Embalse la Portiña	Talavera de la Reina	39°57′00	−4°50′00	2.8300	69	2000–2007
Parque del Oeste	Madrid	40°28′00	−3°41′00	2.3658	12	1995–2016
Barrutibasoko Lezkadia	Gautegiz-Arteaga	43°19′0″	−2°40′0″	0.4869	120	2010–2019
La Tejera	Nalda	42°20′0″	−2°29′0″	0.3534	120	2015–2020
Jaizubia	Hondarribia	43°21′0″	−1°49′0″	0.2795	216	2010–2020
Laguna Manjavacas	Mota del Cuervo	39°27′00	−2°52′00	0.1331	60	2011–2016
Barajas	Paracuellos del Jarama	40°28′11″	−3°31′37″	−0.5088	78	2019

Table 1. *Cont.*

Station Name	Town	Latitude	Longitude	Urbanization Index	Mist Net Pool Length (m)	Data Range
Río Guadalix—Embalse Pedrezuela	Guadalix de la Sierra	40°47′9″	−3°40′42″	−0.6537	90	2019–2020
Mejana del Casetón	Sobradiel-Utebo	41°44′0″	−1°1′0″	−0.7962	84	2017–2020
Ubagua	Riezu-Muez	42°45′13″	−1°56′33″	−0.8099	126	2019–2020
Loza	Loza	42°50′0″	−1°43′0″	−0.8176	156	2012–2021
La Nava	Fuentes de Nava	42°4′0″	−4°45′0″	−0.8440	60	2013–2020
Las Cañas	Viana	42°29′0″	−2°24′0″	−0.8694	120	2013–2021
Las Minas	San Martín de la Vega	40°14′00	−3°33′00	−0.8802	138	1995–2021
Autillos	Pina de Ebro	41°30′0″	−0°23′0‴	−0.8892	60	2017–2019
Cortijo de Auta	Riogordo	36°55′00	−4°16′00	−0.9939	52	1997–2007 2019–2020
Río Salado	Almargen	37°1′00	−5°10′00	−1.0148	27	2000–2007
Motondo	Orio	43°16′0″	−2°17′0″	−1.0825	174	2010–2020
Arroyo Samburiel	Manzanares el Real	40°45′00	−3°52′00	−1.14033	67	2002–2009
Soto del Rincón Falso	Pastriz	41°36′0″	−0°45′0‴	−1.1800	72	2017–2019
La Higueruela	Santa Olalla	40°00′00	−4°25′00	−1.2186	48	1995–2009
Santa Eulalia	Arnedo	42°13′0″	−2°12′0″	−1.2621	120	2012–2020
La Veguilla	Córdoba	37°51′00	−4°42′00	−1.3021	60	2002–2009
Dehesa de Castrillo	Toro	41°28′00	−5°26′00	−1.3142	54	1999–2004

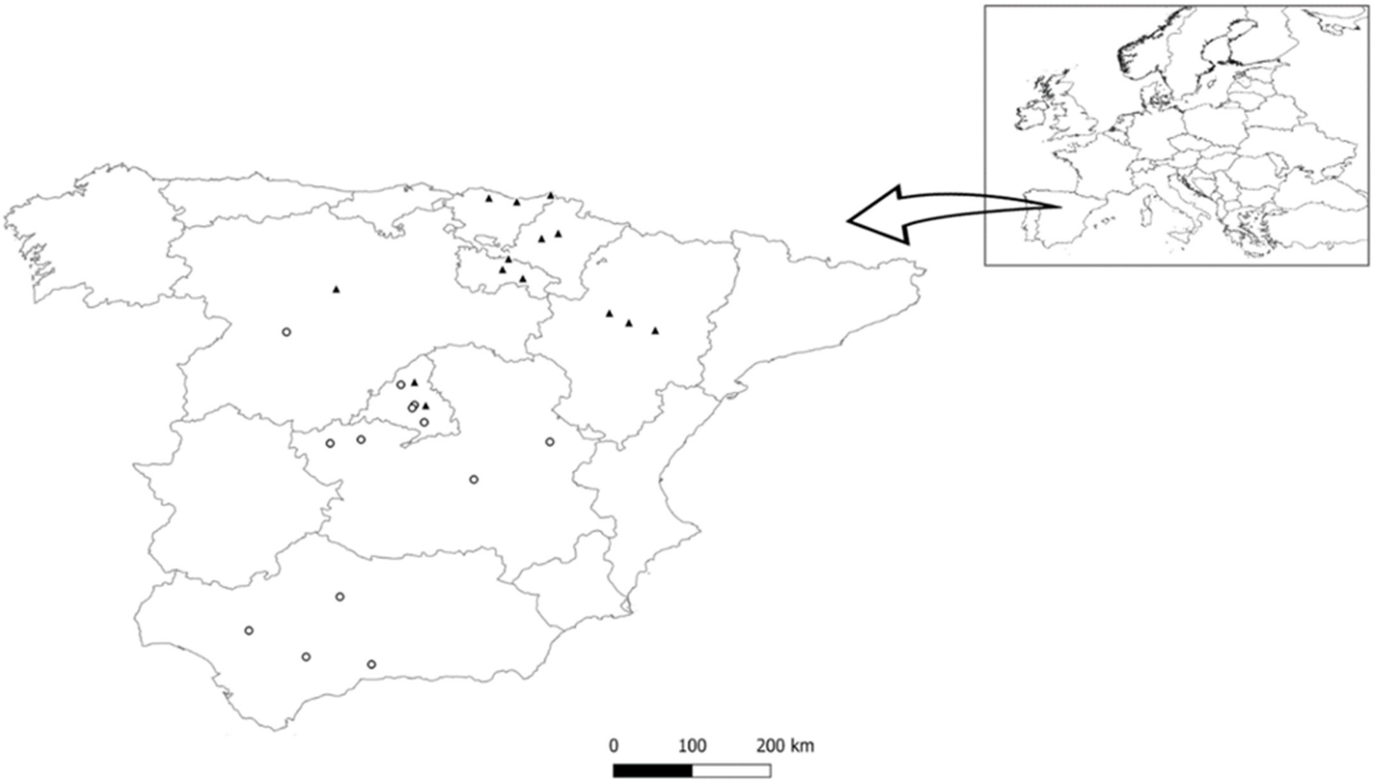


Figure 1. Locations of CES across Spanish regions. Locations from the PASER program in circles, locations from the EMAN program in triangles.

To determine how urbanization affected sparrow populations, we characterized the habitat in a 1 km^2 plot around each ringing station with different parameters: vegetation, buildings, pavement, and water following Liker et al., 2008 [46]. A grid containing 100 cells of 100 m × 100 m was plotted over a satellite picture and a percentage (0–100%) of the previous parameters (vegetation, buildings, pavement, and water) was assigned to each cell. As two different observers analysed different ringing stations, a repeatability test was carried out (r = 0.9993), thus enabling us to merge both scores.

2.2. Statistical Methods

To assign an urbanization index to each ringing station, we performed a principal component analysis (PCA). Component 1 of the PCA (PC1) was interpreted as the urbanization index (eigenvalue = 2.7320; explained variance = 0.6830; factor loadings: vegetation = −0.5671, buildings = 0.5821, pavement = 0.5827, water = −0.0057; see Appendix A). Thus, positive scores in PC1 were related to more urbanized areas whilst negative scores were related to more natural areas (Table 1).

A total of 5080 records of House Sparrow and 2553 records of Tree Sparrow were analysed. Birds were marked and dated as juvenile (hatched individuals from that breeding season) or adults (breeding individuals) following Demongin, 2016 [47]. In order to standardize the effort, since not all ringing stations set up the same number of mist nets, an *index of capture* was calculated by dividing the number of individuals/meters of mist net.

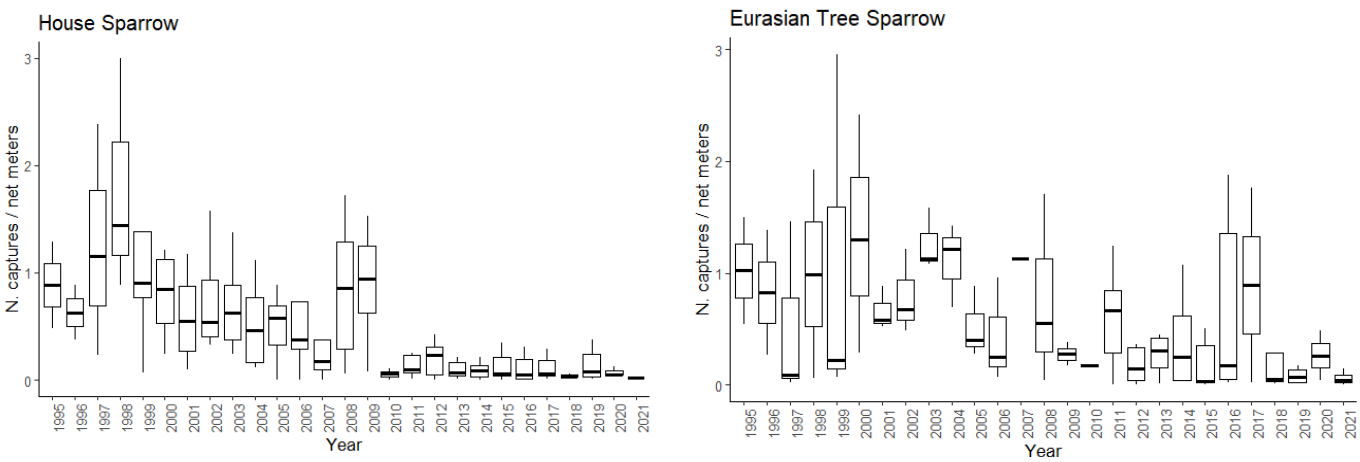
We performed generalized linear mixed models (GLIMMIX, lmer library in R: linear mixed-effects model) to determine differences in the *capture index*, which was used as the response variable. We used the *urbanization index* and *year* as covariates and *ringing station* as a random factor.

To analyse changes in productivity in all those years, we created a *productivity index* by subtracting the number of adults to the number of juveniles per year (*productivity index*: juveniles—adults). A negative index would indicate a higher number of adults, a positive one would indicate more juveniles, and 0 would indicate an equal number of both age groups. We performed another set of GLMM with *productivity* as a response variable, *year* and *urbanization index* as covariates, and *ringing station* as a random factor.

3. Results

3.1. Population Trends

We found a significant decrease in the capture index for both House Sparrow ($p < 0.0001$) and Tree Sparrow ($p = 0.0037$) over the study period (1995–2021) (Figure 2, Table 2).



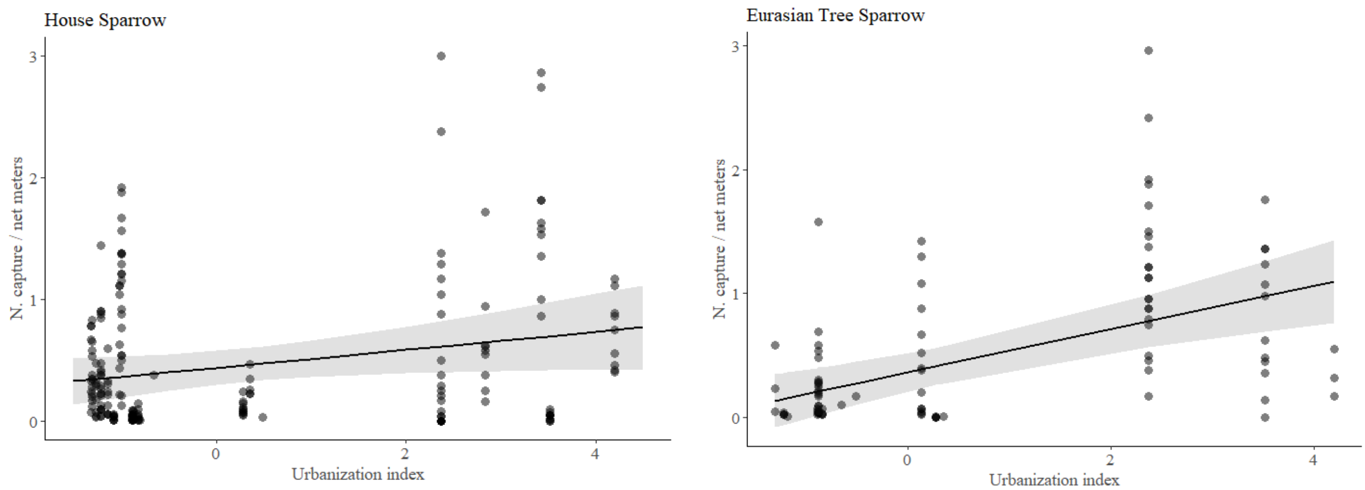
(**a**) (**b**)

Figure 2. Capture index for House Sparrow (**a**) and Tree Sparrow (**b**) over the study years. Mean value, upper and lower quartiles, and maximum and minimum values are represented by line, boxes, and whiskers, respectively.

Table 2. Generalized linear mixed models. *p*-values marked in bold indicate significance ($p < 0.05$).

HOUSE SPARROW		**Estimate**	**SE**	**F**	**Df**	***p***
Population trends	Intercept	0.9550	0.2846	11.2266	1	**0.0010**
	urban index	0.0738	0.0378	3.8047	1	0.0683
	year	−0.0171	0.3236	2.9104	26	**<0.0001**
Productivity	Intercept	−15.9132	12.4865	1.6213	1	0.2047
	urban index	0.0941	2.3035	0.0942	1	0.7627
	year	4.5000	16.1885	1.2715	26	0.1872
TREE SPARROW		**Estimate**	**SE**	**F**	**Df**	***p***
Population trends	Intercept	0.7432	0.3013	5.9202	1	**0.0177**
	urban index	0.1749	0.0412	16.5448	1	**0.0043**
	year	-0.1950	0.4059	2.3302	26	**0.0037**
Productivity	Intercept	11.3803	14.1087	0.6329	1	0.4291
	urban index	0.2997	1.9202	0.0224	1	0.8851
	year	3.4740	17.4493	1.3893	26	0.1479

However, we found marginally significant differences for House Sparrow between the urbanization index and the captures ($p = 0.0683$). Capture index increased more in urbanized areas than in natural ones. In the case of Tree Sparrow, we found significant differences in the capture index in relation to urbanization ($p = 0.0043$) (Figure 3, Table 2).



(**a**) (**b**)

Figure 3. Capture index for House Sparrow (**a**) and Tree Sparrow (**b**) in relation to the urbanization index (PCA component 1: left is natural, right is urban). Grey shadowed area represents confidence interval.

3.2. Productivity

We found no significant differences in productivity between the years in neither House Sparrow ($p = 0.1872$) nor in Tree Sparrow ($p = 0.1479$). Similarly, there were no significant differences in productivity depending on the urbanization index with which the ringing station was characterized (for House Sparrow, $p = 0.7627$; for Tree Sparrow, $p = 0.8851$) (Figures 4 and 5, Table 2).

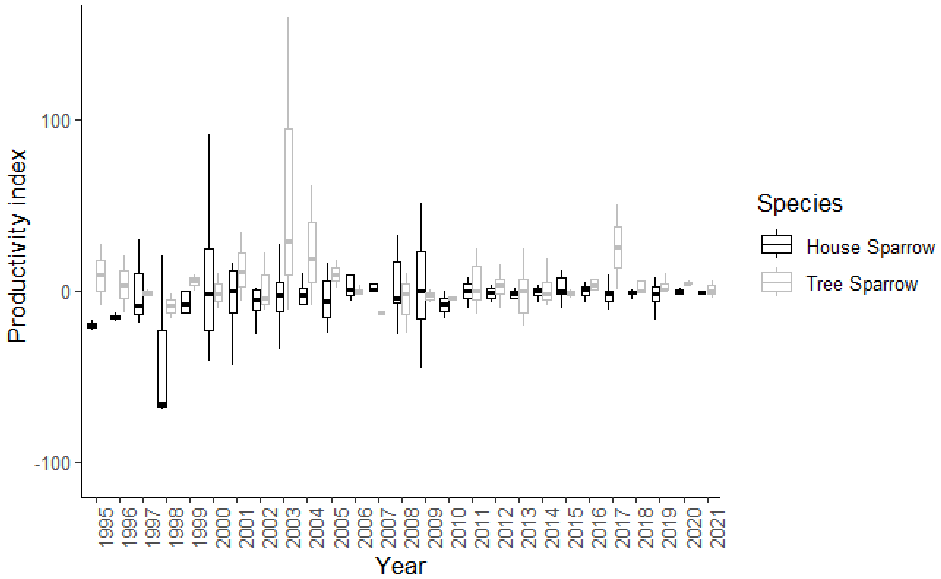


Figure 4. Productivity index (number of juveniles—number of adults) for House Sparrow (black) and Tree Sparrow (grey) over the study interval. Boxes represent upper and lower quartiles. Mean value and maximum and minimum values are represented by line and whiskers, respectively.

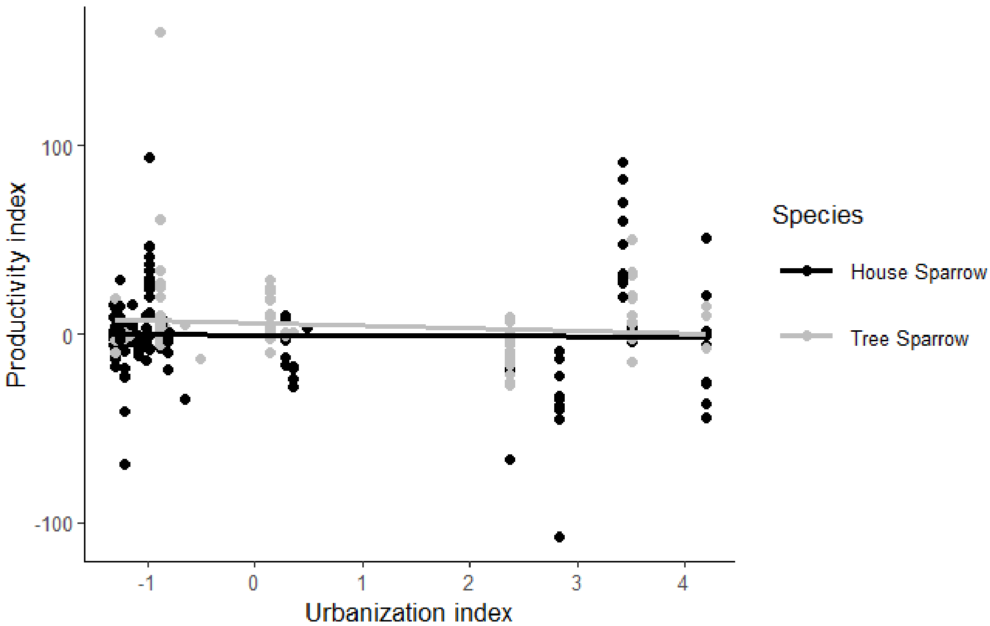


Figure 5. Productivity index (number of juveniles—number of adults) for House Sparrow (black) and Tree Sparrow (grey) according to the urbanization index (PCA component 1).

4. Discussion

Our long-term study of Spanish House Sparrows and Tree Sparrows strongly suggests a continuous decline in the population of both species over the study years, not only in highly urbanized areas but also in the more natural ones. What we can gather from our results is that the decreasing population trend in both urban and natural areas means that there must be a group of general causes affecting the populations rather than particular local conditions. Although different limiting factors could influence the decrease in the urban population, our data indicate that it is not related to a decrease in productivity in any area, since its index remains the same along the years studied and along the urbanization index.

The decreasing situation of the two species could be due to many different factors since there seems to be no single reason that explains the observed situation entirely; these are discussed below. It is true that cities provide some benefits for species, like a constant food supply; however, there must be a cause for such decline [6]. Some authors have pointed out that the disappearance of favourable habitat and lack of breeding sites may be one of the reasons [21,37]. In relation to the absence of breeding locations, both species lean towards using the space under roof tiles to nest in urban areas [48]. It was shown by Shaw et al. in 2008 that more sparrows can be found in low socioeconomic status locations than in wealthy areas since construction flaws are almost non-existent in affluent regions, making it more difficult for them to nest [37]. To compensate for the lack of nesting spaces, nest-boxes are usually suggested. Interestingly, Tree Sparrows do use nest-boxes but House Sparrows are more indifferent, only using them in some cases where sub-optimal nesting sites had been lost [48,49].

In addition, a descending number of feeding resources such as arthropods in cities may be associated with the decreasing trend of sparrows, since nestlings are fed with them, a lower quantity of insectivore diet could lead to a reduced fitness for the individuals [50–52].

Competition with other species could also be a reason leading to the population decrease, due to the use of similar resources and aggressive behaviours to defend them, such as invasive species, e.g., Monk Parakeets (*Myiopsitta monachus*) [53–55]. Predators are another factor to take into consideration, even though cities cannot compare to natural areas when talking about predators, feral cats and free-ranging domestic cats are one of the main causes of biodiversity loss in urban areas [11,12,56].

Another key point is contamination of the environment, such as electromagnetic radiation, additives in fuels, or pollution in the system (atmosphere, ground, and water) [13,57,58]. Probably a combination of these factors and/or others unidentified may be causing the observed decline.

At the same time, Tree Sparrows were thought to inhabit more natural areas, but our research shows how captures increase with more urbanized ringing station locations in contrast to what we had previously predicted [30,33]. House Sparrows are more aggressive than Tree Sparrows, excluding the last ones from favourable nest-sites. Therefore, the decrease in House Sparrow population could lead to an increase in the Tree Sparrow population in urban areas thanks to the absence of the former [48,59]. Nonetheless, Tree Sparrows are influenced by human activity, preferring urban places where it is not so crowded and where they can find a great portion of vegetation. In cities, they prefer places where they can find natural resources, as well as holes in low buildings to nest [31]. The increasing urban population of Tree Sparrows found in our results can reflect occupation on more natural areas within urban cities, for instance, private gardens in residential places [48].

Our data also show that, even with decreasing trends in population, productivity does not change neither along the years nor along the urbanization index. This means that whatever is causing the declining trend in House Sparrow and Tree Sparrow populations, it affects both adults and juveniles. Fitness would be reduced, meaning they would have less offspring. Related to the invariable productivity, birds' breeding seasons are longer in urban areas than in natural ones, having more time to lay more eggs, compensating for their potentially shorter lifespan [60]. Additionally, along these lines, a greater amount of food in urban areas may lead to a higher number of chicks per breeding season, though the quality food is not good enough for a large nestling's lifespan [7,60].

According to Spanish national censuses, and in view of the arguments above, we can conclude that House Sparrow and Tree Sparrow populations are decreasing in Spain. There is no single cause for this event, but it seems that there may be multiple factors involved. Nonetheless, in some North Palearctic areas, there is evidence that Tree Sparrow populations are increasing [33]. In a widely distributed species, such as Tree Sparrow and House Sparrow, population trends in the peripherical areas of the Palearctic distribution do not necessarily have to match with the trends throughout the entire distribution.

Not only that, Tree Sparrows (which used to settle in more natural areas) now unexpectedly seem to be expanding to cities and urban areas. Again, we are not aware of the reason why, but it could be related to the occupancy of empty niches due to the decrease in House Sparrow numbers. However, our data show how productivity remains the same over the study years and locations, which means that the cause of the decline in both populations seems to affect not only adults but also juveniles.

This research shows how constant effort sites are a useful tool to assess trends in bird populations thanks to large periods of time records. Nevertheless, the knowledge of actual reasons for particular declines requires specific approaches and studies that CES data might lack. Further research should be carried out in order to be able to properly identify the causes for the decline of both species' populations.

Author Contributions: Conceptualization, E.B. and J.I.A.; methodology, E.R.-E., E.B. and J.I.A.; formal analysis, E.R.-E. and J.I.A.; data curation, E.R.-E., E.B., J.A., D.M. and J.I.A.; writing—original draft preparation, E.R.-E.; writing—review and editing, E.R.-E., E.B., J.A., D.M. and J.I.A.; supervision, J.I.A. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement: All the trapping was carried out over the entire study (1995–2022) following Spanish Nature and Conservation policies.

Data Availability Statement: All data are available at the Oficina de Anillamiento from Aranzadi database and the Centro de Migración de Aves, SEO/BirdLife database.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

The principal component analysis shows the urbanization index as the component 1 of the PCA, with a 68.3% of proportion of variance. PC2 increased the variance with an additional 29.37%. However, PC2 was not considered as it only reflects water bodies (Figure A1, Table A1).

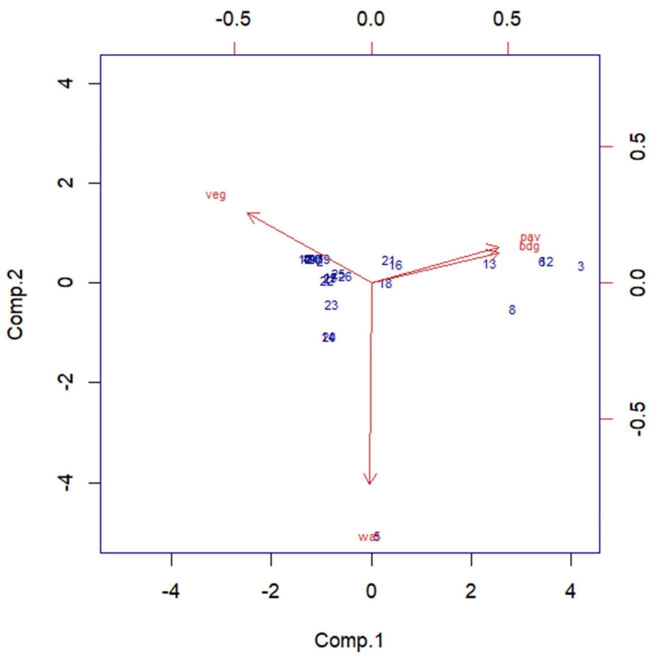

Figure A1. Graphical plot of the principal component analysis. "Veg" refers to vegetation, "Pav" refers to pavement, "Bdg" refers to buildings, and "Wat" refers to water.

Table A1. Importance of components.

	Comp. 1	Comp. 2	Comp. 3	Comp. 4
Standard deviation	1.6529	1.0838	0.3053	7.9799×10^{-3}
Proportion of Variance	0.6830	0.2937	0.0233	1.5919×10^{-5}
Cumulative Proportion	0.6830	0.9767	0.9999	1.0000

Component 2 of the PCA (eigenvalue = 1.1746) was not considered since only an urbanization index was wanted. Water sources, which is what PC2 refers to, was not relevant to this study.

References

1. Fahrig, L. Effects of Habitat Fragmentation on Biodiversity. *Annu. Rev. Ecol. Evol. Syst.* **2003**, *34*, 487–515. [CrossRef]
2. Dri, G.F.; Fontana, C.S.; de Sales Dambros, C. Estimating the impacts of habitat loss induced by urbanization on bird local extinctions. *Biol. Conserv.* **2021**, *256*, 109064. [CrossRef]
3. Seress, G.; Liker, A. Habitat urbanization and its effects on birds. *Acta Zool. Acad. Sci. Hung.* **2015**, *61*, 373–408. [CrossRef]
4. Chace, J.F.; Walsh, J.J. Urban effects on native avifauna: A review. *Landsc. Urban Plan.* **2006**, *74*, 46–69. [CrossRef]
5. Katlam, G.; Prasad, S.; Aggarwal, M.; Kumar, R. Trash on the menu: Patterns of animal visitation and foraging behaviour at garbage dumps. *Curr. Sci.* **2018**, *115*, 2322–2326. [CrossRef]
6. Tryjanowski, P.; Skórka, P.; Sparks, T.H.; Biaduń, W.; Brauze, T.; Hetmański, T.; Martyka, R.; Indykiewicz, P.; Myczko, Ł.; Kunysz, P.; et al. Urban and rural habitats differ in number and type of bird feeders and in bird species consuming supplementary food. *Environ. Sci. Pollut. Res.* **2015**, *22*, 15097–15103. [CrossRef] [PubMed]
7. Salmon, P.; Nilsson, J.F.; Nord, A.; Bensch, S.; Isaksson, C. Urban environment shortens telomere length in nestling great tits, Parus major. *Biol. Lett.* **2016**, *12*, 20160155. [CrossRef]
8. Toledo, A.; Andersson, M.N.; Wang, H.L.; Salmón, P.; Watson, H.; Burdge, G.C.; Isaksson, C. Fatty acid profiles of great tit (*Parus major*) eggs differ between urban and rural habitats, but not between coniferous and deciduous forests. *Sci. Nat.* **2016**, *103*, 55. [CrossRef] [PubMed]
9. Clavel, J.; Julliard, R.; Devictor, V. Worldwide decline of specialist species: Toward a global functional homogenization? *Front. Ecol. Environ.* **2011**, *9*, 222–228. [CrossRef]
10. Anderies, J.M.; Katti, M.; Shochat, E. Living in the city: Resource availability, predation, and bird population dynamics in urban areas. *J. Theor. Biol.* **2007**, *247*, 36–49. [CrossRef]
11. Lepczyk, C.A.; Mertig, A.G.; Liu, J. Landowners and cat predation across rural-to-urban landscapes. *Biol. Conserv.* **2004**, *115*, 191–201. [CrossRef]
12. Beckerman, A.P.; Boots, M.; Gaston, K.J. Urban bird declines and the fear of cats. *Anim. Conserv.* **2007**, *10*, 320–325. [CrossRef]
13. Khan, M.A.; Ghouri, A.M. Environmental Pollution: Its effects on life and its remedies. *Res. World J. Arts Sci. Commer.* **2011**, *2*, 276–285.
14. Khatri, N.; Tyagi, S. Influences of natural and anthropogenic factors on surface and groundwater quality in rural and urban areas. *Front. Life Sci.* **2014**, *8*, 23–39. [CrossRef]
15. Blumstein, D.T.; Fernández-Juricic, E.; Zollner, P.A.; Garity, S.C. Inter-specific variation in avian responses to human disturbance. *J. Appl. Ecol.* **2005**, *42*, 943–953. [CrossRef]
16. De Laet, J.; Summers-Smith, J.D. The status of the urban house sparrow Passer domesticus in north-western Europe: A review. *J. Ornithol.* **2007**, *148* (Suppl. 2), 275–278. [CrossRef]
17. Anderson, T.R. *Biology of the Ubiquitous House Sparrow*; Oxford University Press: Oxford, UK, 2006.
18. Chávez-Zichinelli, C.A.; MacGregor-Fors, I.; Rohana, P.T.; Valdéz, R.; Romano, M.C.; Schondube, J.E. Stress responses of the House Sparrow (*Passer domesticus*) to different urban land uses. *Landsc. Urban Plan.* **2010**, *98*, 183–189. [CrossRef]
19. Ericson, P.G.P.; Tyrberg, T.; Kjellberg, A.S.; Jonsson, L.; Ullén, I. The earliest record of house sparrows (Passer domesticus) in Northern Europe. *J. Archaeol. Sci.* **1997**, *24*, 183–190. [CrossRef]
20. Sætre, G.-P.; Riyahi, S.; Aliabadian, M.; Hermansen, J.S.; Hogner, S.; Olsson, U.; Gonzalez, M.F.; Sæther, S.A.; Trier, C.N.; Elgvin, T.O. Single origin of human commensalism in the house sparrow. *J. Evol. Biol.* **2012**, *25*, 788–796. [CrossRef]
21. Chamberlain, D.E.; Toms, M.P.; Cleary-McHarg, R.; Banks, A.N. House Sparrow (*Passer domesticus*) habitat use in urbanized landscapes. *J. Ornithol.* **2007**, *148*, 453–462. [CrossRef]
22. Summers-Smith, J. *The Sparrows*; A&C Black Publishers: London, UK, 1988.
23. Brichetti, P.; Rubolini, D.; Galeotti, P.; Fasola, M. Recent declines in urban Italian Sparrow Passer (*domesticus*) italiae populations in northern Italy. *Ibis* **2008**, *150*, 177–181. [CrossRef]
24. Siriwardena, G.M.; Baillie, S.R.; Buckland, S.T.; Fewster, R.M.; Marchant, J.H.; Wilson, J.D. Trends in the abundance of farmland birds: A quantitative comparison of smoothed Common Birds Census indices. *J. Appl. Ecol.* **1998**, *35*, 24–43. [CrossRef]

25. Klok, C.; Holtkamp, R.; van Apeldoorn, R.; Visser, M.E.; Hemerik, L. Analysing Population Numbers of the House Sparrow in the Netherlands With a Matrix Model and Suggestions for Conservation Measures. *Acta Biotheor.* **2006**, *54*, 161–178. [CrossRef]
26. Robinson, R.A.; Siriwardena, G.M.; Crick, H.Q.P. Size and trends of the House Sparrow Passer domesticus population in Great Britain. *Ibis* **2005**, *147*, 552–562. [CrossRef]
27. Murgui, E. Gorrión común Passer domesticus. In *III Atlas de las Aves en época de Reproducción en España*; Molina, B., Nebreda, A., Muñoz, A.R., Seoane, J., Real, R., Bustamante, J., del Moral, J.C., Eds.; SEO/BirdLife: Madrid, Spain, 2022; Available online: https://atlasaves.seo.org/ave/gorrion-comun/ (accessed on 14 April 2022).
28. Field, R.H.; Anderson, G.Q.A. Habitat use by breeding Tree Sparrows Passer montanus. *Ibis* **2004**, *146*, 60–68. [CrossRef]
29. García-Navas, V.; Sanz, J.J. Yearly and Seasonal Variation of Breeding Parameters in a Declining Multi-Brooded Passerine, the Tree Sparrow. *Ardea* **2012**, *100*, 79–88. [CrossRef]
30. Zhang, S. Habitat use of urban tree Sparrows in the process of urbanization: Beijing as a case study. *Front. Biol. China* **2008**, *3*, 308–314. [CrossRef]
31. Zhang, S.; Zheng, G. Effect of urbanization on the abundance and distribution of Tree Sparrows (*Passer montanus*) in Beijing. *Chin. Birds* **2010**, *1*, 188–197. [CrossRef]
32. Tomiałojć, L. Changes In Tree Sparrow Passer Montanus Populations From Urban Parks. *Intern. Stud. Sparrows* **2012**, *36*, 4–17. [CrossRef]
33. Jokimäki, J.; Suhonen, J.; Kaisanlahti-Jokimäki, M.-L. Differential Long-Term Population Responses of Two Closely Related Human-Associated Sparrow Species with Respect to Urbanization. *Birds* **2021**, *2*, 230–249. [CrossRef]
34. SEO/BirdLife. *Resultados del Programa Sacre de SEO/BirdLife*; SEO/BirdLife: Madrid, Spain, 2013.
35. BirdLife International. *European Birds of Conservation Concern: Populations, Trends and National Responsibilities*; Birdlife International: Cambridge, UK, 2017.
36. Vepsäläinen, V.; Pakkala, T.; Tiainen, J. Population increase and aspects of colonization of the Tree Sparrow Passer montanus, and its relationships with the House Sparrow Passer domesticus, in the agricultural landscapes of Southern Finland. *Ornis Fenn.* **2005**, *82*, 117–128.
37. Shaw, L.M.; Chamberlain, D.; Evans, M. The House Sparrow Passer domesticus in urban areas: Reviewing a possible link between post-decline distribution and human socioeconomic status. *J. Ornithol.* **2008**, *149*, 293–299. [CrossRef]
38. Hooge, P.N.; Stanback, M.T.; Koenig, W.D. Nest-Site Selection in the Acorn Woodpecker. *Auk* **1999**, *116*, 45–54. [CrossRef]
39. Tordoff, H.B.; Martell, M.S.; Redig, P.T. *Midwest Peregrine Falcon Restoration, 1996 Report*; Bell Museum of Natural History and the Raptor Center, University of Minnesota: St. Paul, MN, USA, 1997.
40. Summers-Smith, J.D. The decline of the House Sparrow: A review. *Br. Birds* **2003**, *96*, 439–446.
41. SEO/BirdLife. *SEO/BirdLife 2011 Birds Monitoring Programmes*; SEO/BirdLife: Madrid, Spain, 2012; pp. 14–15.
42. Bermejo, A.; Palomino, D. Ringing Plan for Breeding Species Monitoring. In *Programs of Monitoring of SEO/BirdLife in 2005*; Escandell, V., Ed.; PASER Program; SEO/BirdLife: Madrid, Spain, 2007.
43. Arizaga, J.; Crespo, A.; Iraeta, A. Sociedad de Ciencias Aranzadi. *Noticias EMAN* **2020**, *8*. Available online: http://www.aranzadi.eus/oficina-anillamiento (accessed on 14 April 2022).
44. Robinson, R.A.; Julliard, R.; Saracco, J.F. Constant effort: Studying avian population processes using standardised ringing. *Ringing Migr.* **2009**, *24*, 199–204. [CrossRef]
45. Kampichler, C.; van der Jeugd, H.P. Monitoring Passerine Reproduction by Constant Effort Ringing: Evaluation of the Efficiency of Trend Detection. *Ardea* **2011**, *99*, 129–136. [CrossRef]
46. Liker, A.; Papp, Z.; Bókony, V.; Lendvai, Á.Z. Lean birds in the city: Body size and condition of house Sparrows along the urbanization gradient. *J. Anim. Ecol.* **2008**, *77*, 789–795. [CrossRef]
47. Demongin, L. *Identification Guide to Birds in the Hand*; Privately Published: Beauregard-Vendon, France, 2016.
48. Šálek, M.; Riegert, J.; Grill, S. House Sparrows Passer domesticus and Tree Sparrows Passer montanus: Fine-Scale Distribution, Population Densities, and Habitat Selection in a Central European city. *Acta Ornithol.* **2015**, *50*, 221–232. [CrossRef]
49. Węgrzynowicz, A. Importance Of Nest Sites Availability For Abundance And Changes In Number Of House- And Tree Sparrow In Warsaw. *Intern. Stud. Sparrows* **2012**, *36*, 56–65. [CrossRef]
50. Summers-Smith, J.D. Densities of House Sparrows in Different Urban Habitats in a Small Town in NE England. *J. Yamash. Inst. Ornithol.* **2009**, *40*, 117–124. [CrossRef]
51. Murgui, E.; Macias, A. Changes in the House Sparrow Passer domesticus population in Valencia (Spain) from 1998 to 2008. *Bird Stud.* **2010**, *57*, 281–288. [CrossRef]
52. Jokimäki, J.; Kaisanlahti-Jokimäki, M.-L. Urban Birds Using Insects on Front Panels of Cars. *Birds* **2023**, *4*, 15–27. [CrossRef]
53. Cooper, C.B.; Hochachka, W.M.; Dhondt, A.A. Contrasting natural experiments confirm competition between house finches and house Sparrows. *Ecology* **2007**, *88*, 864–870. [CrossRef] [PubMed]
54. Freeland, D.B. Some Food Preferences and Aggressive Behavior by Monk Parakeets. *Wil. Bull.* **1973**, *85*, 332–334.
55. Appelt, C.W.; Ward, L.C.; Bender, C.; Fasenella, J.; Vossen, B.J.V.; Knight, L. Examining potential relationships between exotic monk parakeets (*Myiopsitta monachus*) and avian communities in an urban environment. *Wilson J. Ornithol.* **2016**, *128*, 556–566. [CrossRef]
56. Jessup, D.A. The welfare of feral cats and wildlife. *J. Am. Vet. Med. Assoc.* **2004**, *225*, 1377–1383. [CrossRef]

57. Balmori, A.; Hallberg, Ö. The Urban Decline of the House Sparrow (*Passer domesticus*): A Possible Link with Electromagnetic Radiation. *Electromagn. Biol. Med.* **2007**, *26*, 141–151. [CrossRef]
58. Summers-Smith, J.D. Is unleaded petrol a factor in urban House Sparrow decline? *Br. Birds* **2007**, *100*, 558–559.
59. Cordero, P.J.; Senar, J.C. Interspecific Nest Defence in European Sparrows: Different Strategies to Deal with a Different Species of Opponent? *Ornis Scand.* **1990**, *21*, 71. [CrossRef]
60. Chamberlain, D.E.; Cannon, A.R.; Toms, M.P.; Leech, D.I.; Hatchwell, B.J.; Gaston, K.J. Avian productivity in urban landscapes: A review and meta-analysis. *Ibis* **2009**, *151*, 1–18. [CrossRef]